# RADIO

ESTABLISHED 1917

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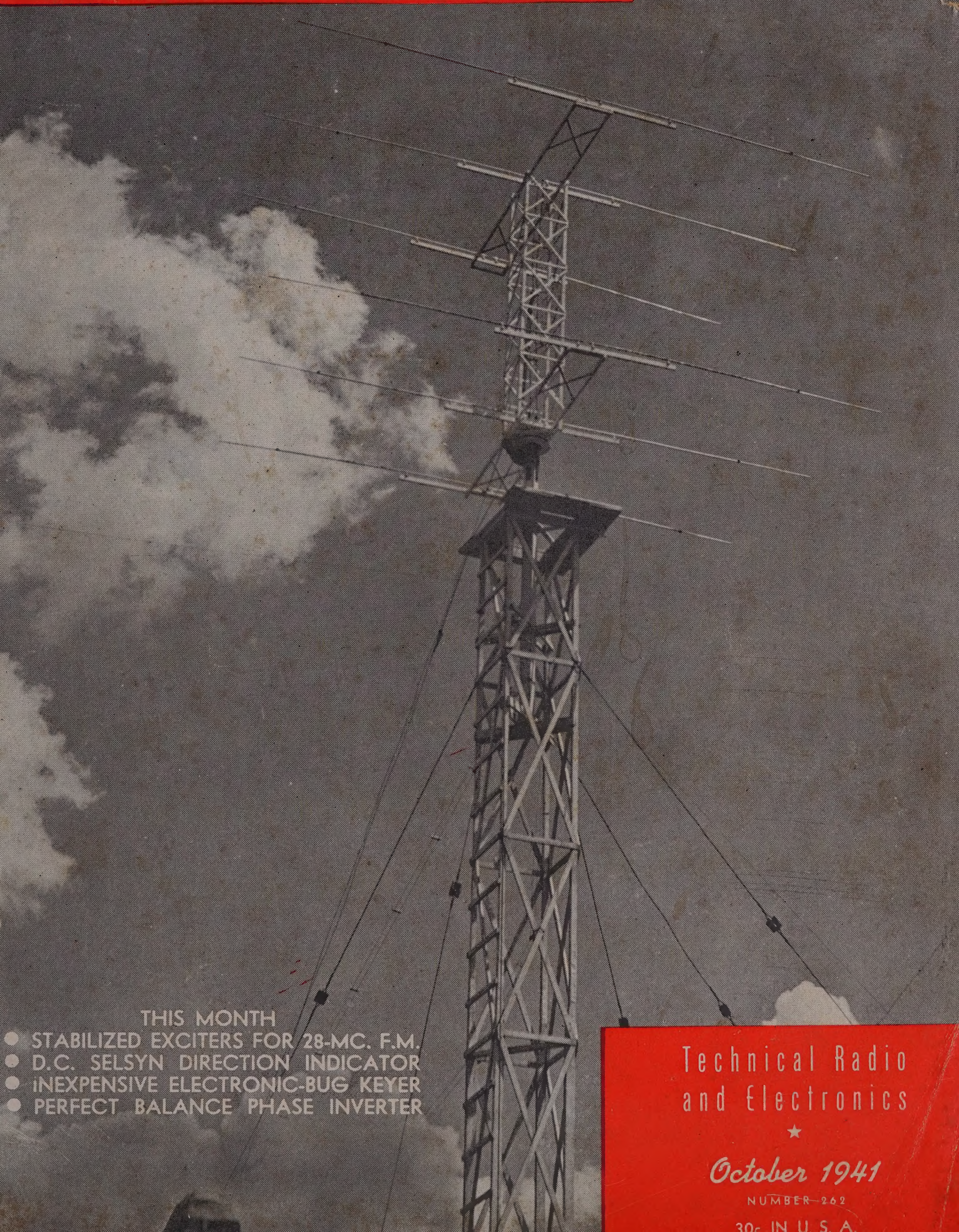

THIS MONTH
- STABILIZED EXCITERS FOR 28-MC. F.M.
- D.C. SELSYN DIRECTION INDICATOR
- INEXPENSIVE ELECTRONIC-BUG KEYER
- PERFECT BALANCE PHASE INVERTER

Technical Radio and Electronics

★

October 1941

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# Past • Present and • Prophetic

### Changes in Amateur Frequency Allocations

At the request of the ARRL, the FCC has authorized phone operation in the band from 28.1 Mc. to 30 Mc., instead of from 28.5 Mc. to 30 Mc., as before. In addition, the frequencies from 29.25 Mc. to 30 Mc. are assigned for f.m. transmission. This action was taken to accommodate the increasing number of phone stations and, at the same time, to encourage amateur f.m. work.

The Commission also amended Section 12.63 to eliminate misunderstanding about the requirement that an amateur desiring to operate a station by remote control must submit complete information regarding location of the control point, his right to the use of the premises, the means by which remote control is effected, and the equipment to be used to monitor the transmissions from the control point. As has long been the case, amateur operation, directly or remotely, is prohibited on premises controlled by an alien.

Temporary cessation of amateur activities in the 3800-3900-kc. band, effective December 20 or sooner, if necessary, has been ordered by the FCC, following its previous announcement that all frequencies between 3650 and 3950 kc. are to be gradually withdrawn from amateur use and turned over to the War Department for use in the pilot training program, on a temporary basis.

The order was issued following a hearing from which it appeared that the amateurs recognized the necessity of the withdrawal for defense purposes and refrained from entering any protest against such military use. However, at this hearing objection was raised to the elimination of the exclusive Class A privileges for amateurs, and the order has been modified to retain such privileges.

The War Department has carefully studied the progress of the pilot training program, and from this study it appears to be necessary to begin partial use of the 3800-3900-kc. band about October 1, 1941, but that it may be possible to use this band jointly with the amateurs until about December 20, 1941. Therefore, the order is issued with the understanding that it may become necessary to advance the date specified. In the meantime, some interference is to be expected from the joint use of the frequencies within this band by the War Department and the amateurs.

### Priorities

For a while it looked as though amateurs would be virtually out of luck when it came to purchasing any one of a large number of parts. However, it now looks as though the restrictions will be relaxed on components, and curtailment of radio production will be confined to complete broadcast receivers. However, the price of parts undoubtedly will go up some more, and certain items may be scarce as a result of defense needs assimilating a large percentage of the production.

But this need not be cause for lament; instead it can be a challenge to the ingenuity of the brethren. Not so many years ago, say prior to 1924, radio amateurs not only assembled their equipment from the component parts, but actually fabricated a majority of the parts. What they did once, they can do again if necessary.

One important item that may become scarce as hen's molars is copper wire. It behooves every one of us to husband what wire we have on hand. When dismantling a piece of equipment, save the hook-up wire. Don't throw away any old burned-out transformers, chokes, etc. that contain usable wire. As previously pointed out in this magazine, galvanized iron wire makes good antenna wire (just in case you are fortunate enough to have a goodly supply of "guywire" on hand). It is quite possible that galvanized iron wire may become as scarce as copper wire.

It behooves each and every one of us to take good care of what gear we have and to avoid any kind of waste.

### Add

With regard to the recent reference in this column to radio amateurs who worked on Walt Disney's "Fantasia," we since have found that if all the hams who had something to do with the work on the picture were laid end to end they would reach from here to there. They are:

W6COF, W6QJ, W6EDS, W6ABF, W6LY, W6WQ, W6OGC, W6SYA, W6RGJ, W6WV, W6MIB, W6BXR, W6BQR, W6KYL, W6GAT, W6AAR, W6KZM, W6KVM, W6HLX, W6KWP, W6KP.

And probably a few more we haven't heard about.

### At Random

Amateurs might well take cognizance of the boost given their prestige by the recent *Reader's Digest* article on servicemen. . . . Keep an eye on the very low plate impedance tube keying circuit used in Clark's electronic bug, beginning on page 36. . . . Be sure and think over the possibilities offered by f.m. operation on the ten-meter band.

# RADIO

*the worldwide authority . . .*

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**No. 262**

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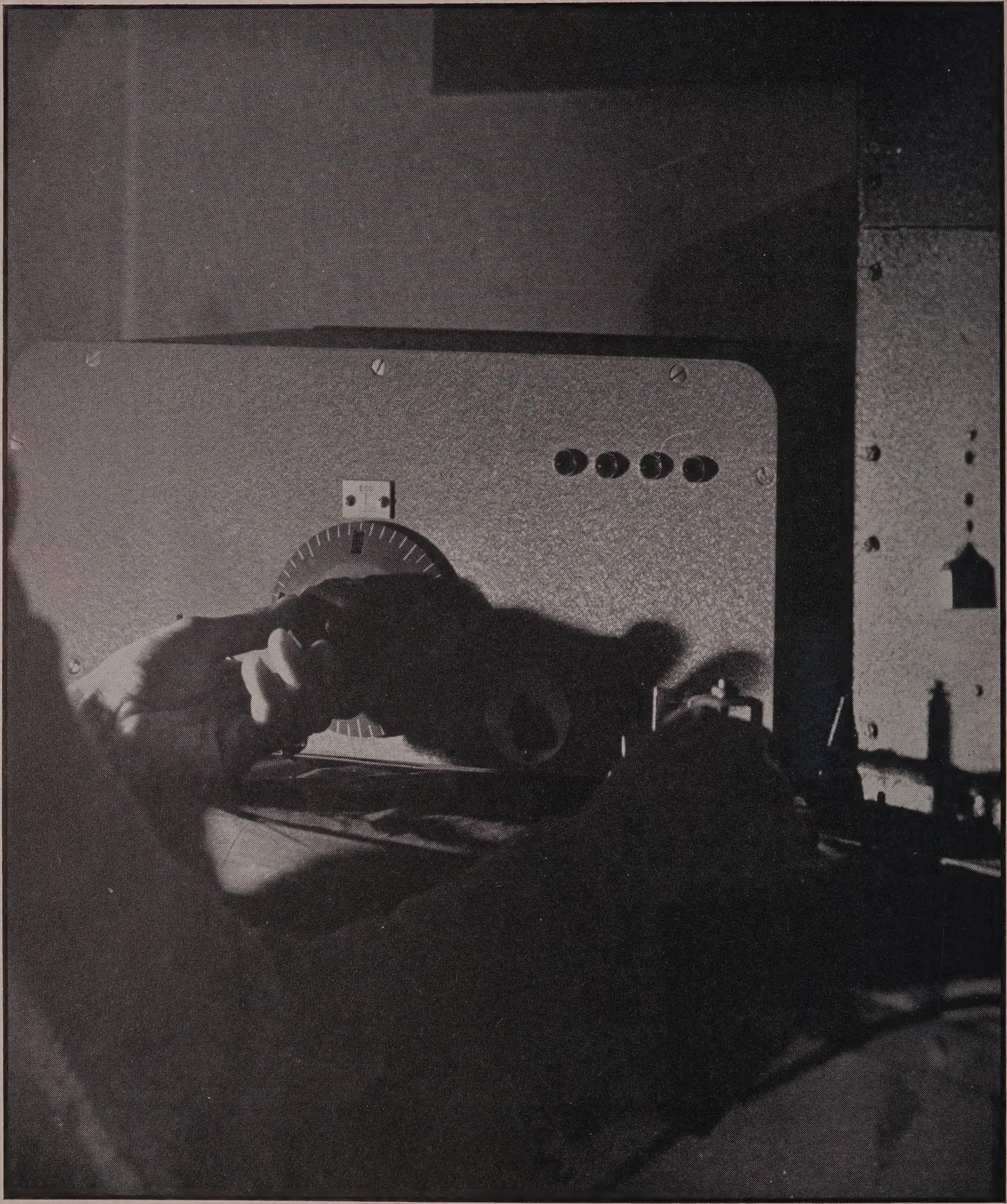


• • • • The operating position at W6HJT, showing the v.f.o. described in the article beginning on the facing page in actual operation.

# A Deluxe

# MULTI-BAND V.F.O. EXCITER

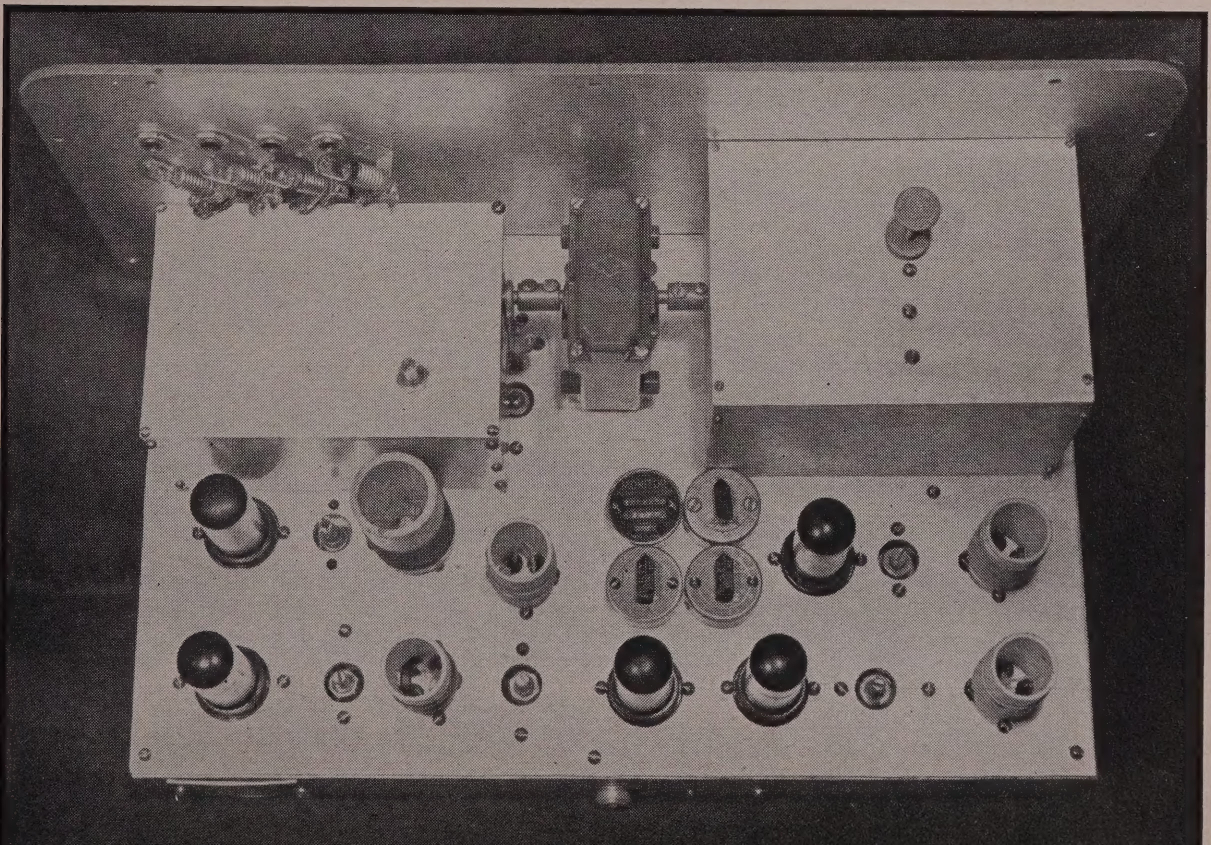
By CAMERON PIERCE, W6HJT

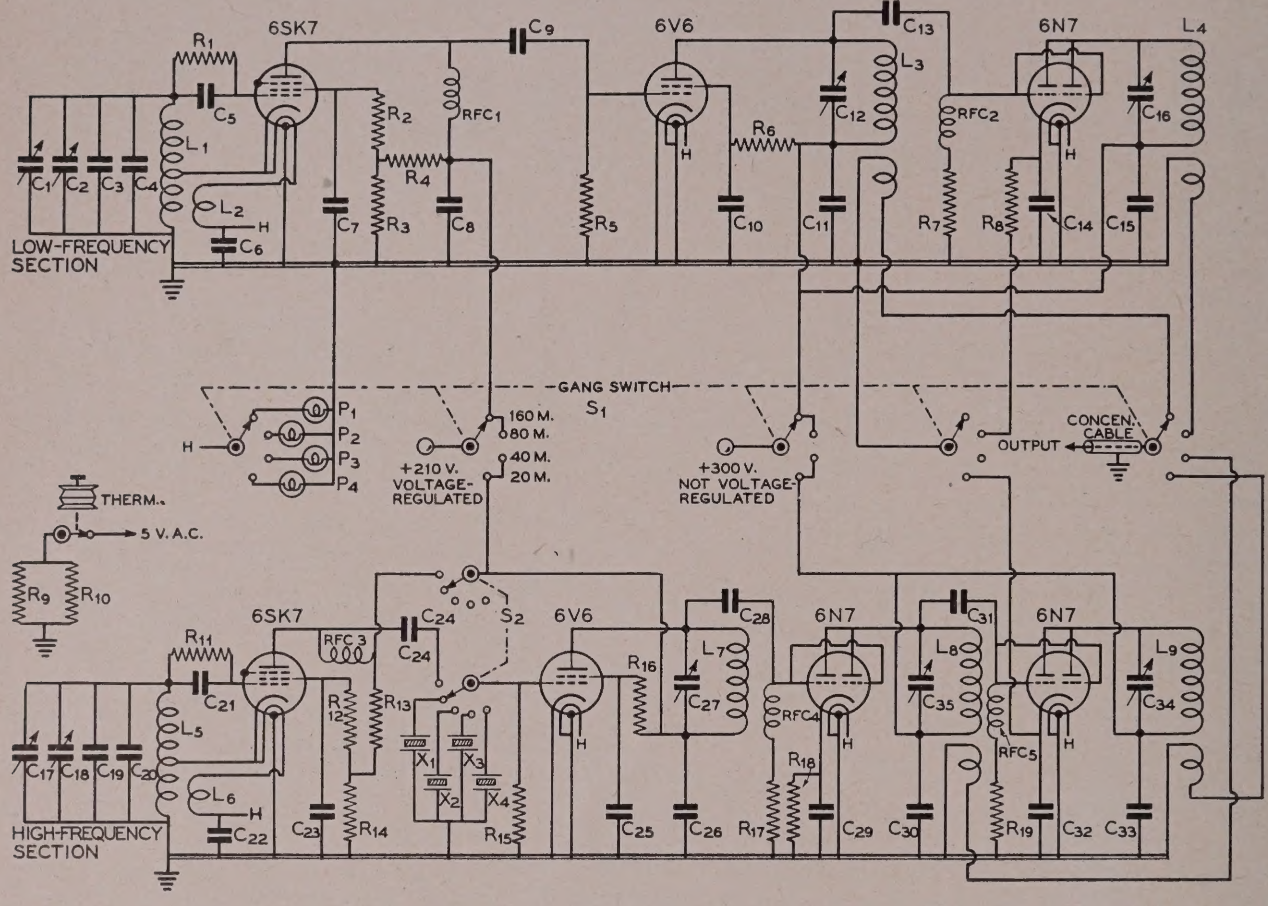
Back in the dim, dark days when dx was the toast of the times, it was the ambition of every dx man to have in his possession an exciter unit that would put his transmitter on any frequency in any band with a twist of the wrist. The stringent requirements of an exciter that meets the wants of the dx man are many, but the writer set out to build an exciter to meet all dx requirements. Since dx has been taboo for some time, and probably will be for a while longer, the unit was built to cover all bands from 160 to 20 meters so that the rig could be used for the many other activities that have taken the place of dx work.

Practically all exciter units proposed in the past have had one or more serious disadvantages. These have been in the form of inadequate frequency stability, necessity of plug-in coils, unequal bandspread on different bands, inflexibility in output frequency (1 or 2 band output, requiring a string of doublers in the rig to reach the high-frequency bands), difficulty in setting the frequency accurately, and insufficient power output. Following is a brief outline of the design and operating characteristics of the deluxe exciter described in this article.

1. Thermostatic control of oscillator temperature to minimize frequency drift at high frequencies.
2. Single control bandswitching covering four bands.
3. Completely separate oscillators for high- and low-frequency bands, resulting in 100% bandspread on every band without the use of plug-in coils or additional padding condensers.
4. Vibration proof as a result of heavy shielding and wiring.
5. No need of retuning any stage during operation over any band.
6. Provision for four marker crystals for high-frequency bands.

Interior construction of the deluxe v.f.o. The oscillator used for control on the two lower frequency bands is in the left compartment; the oscillator used for control on the two higher frequency bands is in the right compartment. The latter compartment is temperature controlled; the adjusting screw for the wafer thermostat may be seen projecting out the top of the box.






Schematic Diagram of Deluxe 20-160 Meter V.F.O.

$C_1$—100-μμfd. midget condenser (bandset)

$C_2$—325-μμfd. midget condenser (tuning). Should have double bearings.

$C_3$—800-μμfd., zero co-efficient ceramic capacitor (actually two 300- and one 200-μμfd. in parallel).

$C_4$—20-μμfd. negative coefficient capacitor (minus .0007)

$C_5$—100-μμfd. mica

$C_6$, $C_7$, $C_8$—.002-μfd. mica

$C_9$—100-μμfd. mica

$C_{10}$, $C_{11}$—.002-μfd. mica

$C_{12}$—50-μμfd. midget

$C_{13}$—100-μμfd. mica

$C_{14}$, $C_{15}$—.002-μfd. mica

$C_{16}$—50-μμfd. midget

$C_{17}$—50-μμfd. midget (tuning). Should have double bearings.

$C_{18}$—100-μμfd. midget variable (bandset)

$C_{19}$—700-μμfd. zero coefficient ceramic capacitor (actually two 200- and one one 300-μμfd. in parallel)

$C_{20}$—10-μμfd. negative coefficient ceramic capacitor (minus .0007)

$C_{21}$—100-μμfd. mica

$C_{22}$, $C_{23}$—.002-μfd. mica

$C_{24}$—100-μμfd. mica

$C_{25}$, $C_{26}$—.002-μfd. mica

$C_{27}$—50-μμfd. midget variable

$C_{28}$—100-μμfd. mica

$C_{29}$, $C_{30}$—.002-μfd. mica

$C_{31}$—100-μμfd. mica

$C_{32}$, $C_{33}$—.002-μfd. mica

$C_{34}$, $C_{35}$—25-μμfd. midget variable

$R_1$—1.5 meg., ½ watt

$R_2$—15,000 ohms, 1 watt

$R_3$, $R_4$—10,000 ohms, 5 watts

$R_5$—100,000 ohms, ½ watt

$R_6$—15,000 ohms, 10 watts

$R_7$—30,000 ohms, 10 watts

$R_8$—400 ohms, 10 watts

$R_9$, $R_{10}$—Resistance wire wound on pillar insulators (see text)

$R_{11}$—1.5 meg., ½ watt

$R_{12}$—15,000 ohms, 1 watt

$R_{13}$, $R_{14}$—10,000 ohms, 10 watts

$R_{15}$—100,000 ohms, ½ watt

$R_{16}$—15,000 ohms, 10 watts

$R_{17}$—3000 ohms, 10 watts

$R_{18}$—400 ohms, 10 watts

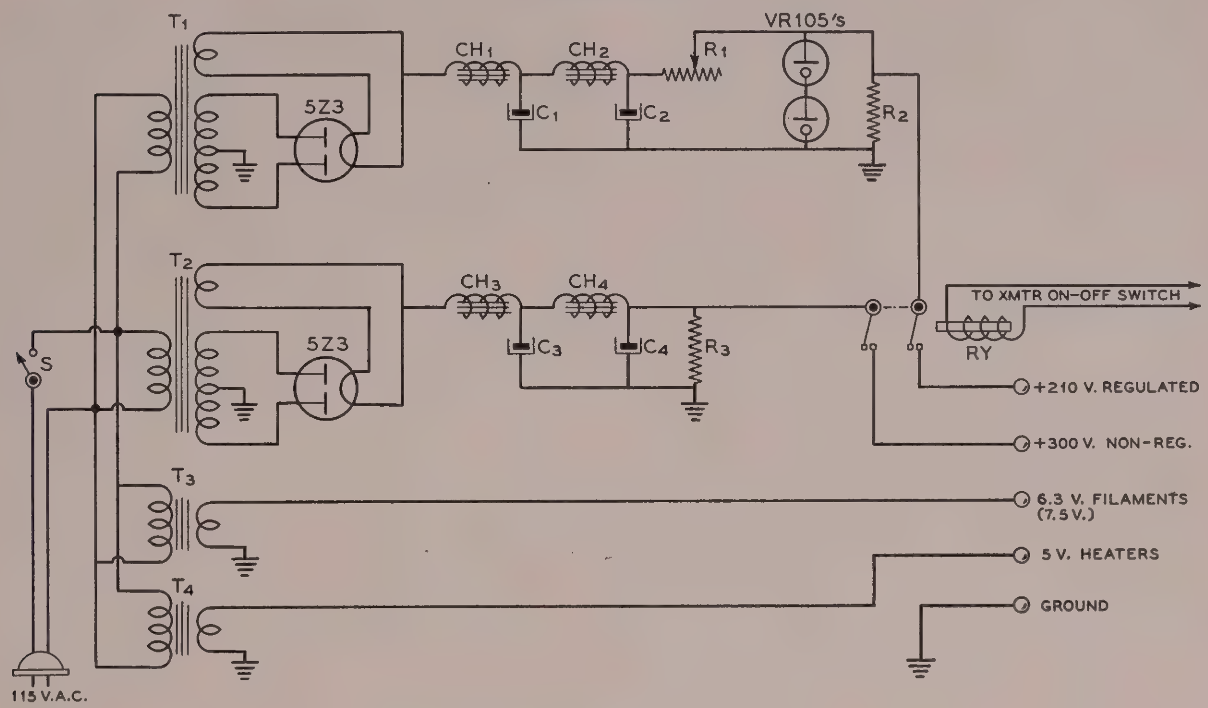
$R_{19}$—15,000 ohms, 10 watts

RFC—2.5 mh. r.f. choke

$S_1$—5 circuit 4 position ceramic switch (actually 3-gang 6-circuit, 5 of which are used)

$S_2$—2-circuit 5-position switch

7. Sufficient output to drive a 100-watt amplifier.
8. Separate power supply to cut down transformer vibration and resulting frequency modulation of the oscillator.
9. Compact and neat appearance.




Schematic of Power Supply Unit

$T_1$—350 v. each side c.t., 75 ma.; 5 v. at 3 amp.
$T_2$—450 v. each side c.t., 150 ma.; 5 v. at 3 amp.
$T_3$—7.5 v. at 5 amp. or more
$T_4$—5 v. at 4 amp.
$CH_1$, $CH_2$—20 hy. at 75 ma.
$CH_3$, $CH_4$—20 hy. at 150 ma.
$C_1$—8-$\mu$fd. electrolytic, 450 v.
$C_2$—16-$\mu$fd. electrolytic, 450 v.
$C_3$—8 $\mu$fd. electrolytic, 450 v.
$C_4$—16-$\mu$fd. electrolytic, 450 v.
RY—Double pole relay with contacts well insulated
$R_1$—5000 ohms, 50 watts, adjustable
$R_2$, $R_3$—100,000 ohms, 1 watt

## The Circuit

The circuit of this exciter can be divided into two separate components: the high-frequency e.c.o. and associated doubler stages, and the low-frequency e.c.o. and its following doublers. These two e.c.o.'s have their tuning condensers ganged to a single National PW dial. The high-frequency e.c.o. operates on the 160-meter band with the tuning capacity so proportioned as to cover a frequency range from 1750 kc. to 1800 kc. with 500 degree bandspread on a National PW dial. This oscillator is followed by a pentode doubler which also acts as a crystal oscillator with the choice of four crystals. Following these 6V6's come two 6N7 doublers that double to 40 and 20 meters respectively. Output from these two stages is obtained through a concentric line which feeds the common output line. The low-frequency e.c.o. operates in the broadcast band (875 kc. to 1025 kc.) and is followed by a 6V6 which doubles the frequency to the 160-meter band, and this tube is followed by a 6N7 which doubles to 80. Output is taken from these last two stages by means of concentric lines as was done in the high-frequency system.

## The Electron-Coupled Oscillators

The e.c.o.'s have identical circuits, namely, the popular Perrine circuit described in RADIO and *QST* in 1939. This circuit has been very satisfactory, and as none better has been found it was incorporated in the e.c.o.'s. The high-frequency e.c.o. is housed in an asbestos lined, duralumin box on the left of the main tuning assembly. The tuning elements are kept at constant temperature by means of a wafer thermostat combined with a Mu switch which in turn operates two small heaters made of nichrome wire wound on stand-off insulators. This thermostat-switch combination may be purchased from the Mu Switch Corp., Canton, Mass. for about $1.50. The use of thermostatic control on the high-frequency e.c.o. reduces the frequency drift under operating conditions by a factor of 1/5, and virtually eliminates the effect of room temperature on the frequency. The low-frequency e.c.o. is not temperature controlled in this particular unit because the drift is negligible below 4000 kc. and elaborate precautions are not necessary to hold the frequency constant. One of the most important factors in the construction of the e.c.o. is the

shielding of the tuned circuits. If the shielding between the grid coil of the e.c.o and the following stages is not complete, feedback will undoubtedly occur, resulting in serious modulation of the note.

## Doubler Stages

In the case of both e.c.o. units, the following doubler tube is a beam tetrode (6V6) which is used because of its power sensitivity, the impedance coupled output circuit of the e.c.o. having a relatively low output power. The following doublers in all cases are 6N7's with the two triode units connected in parallel. A combination of cathode and grid-leak bias is used on these doublers to prevent the plate current from reaching excessively high values during overloads. The plate current on the 6N7 doublers is adjusted to about 70 ma. with 300 volts on the tube plates. The tank circuits are very low C so as to alleviate the need of retuning the circuits when the oscillator frequency is varied over the band.

## Bandswitching

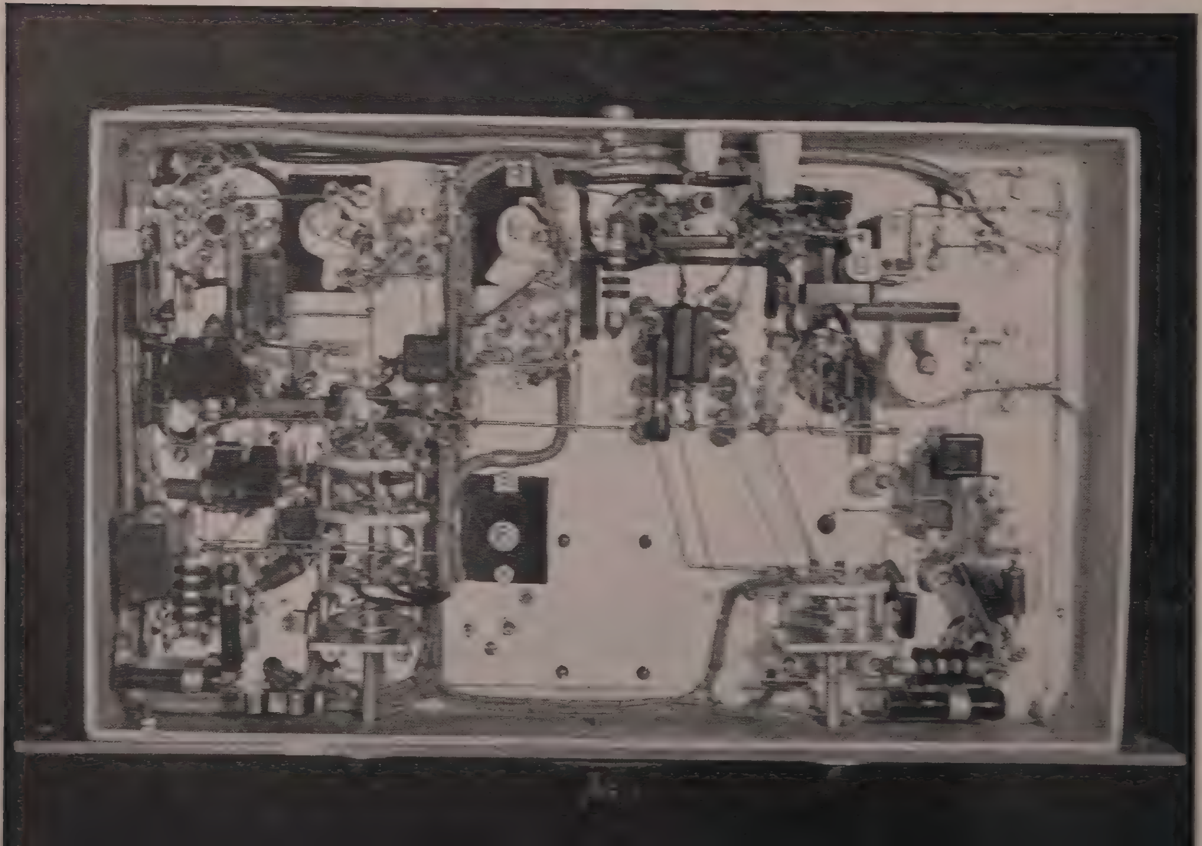
Bandswitching is accomplished by the use of a 6-circuit 4-position ceramic bandswitch. It handles the following circuits: opens cathode circuits of doubler stages not in operation; switches plate voltage between high- and low-frequency sections; switches indicator pilot lights; switches v.r. voltage between e.c.o.'s; switches output concentric line to proper doubler coil; switches keying from one section to the other. The other switch seen in the circuit is used in the high-frequency section to switch between e.c.o and crystal control. The switch takes the plate voltage off the e.c.o. when the crystals are used.

This v.f.o. delivers approximately 5 watts on all bands from 20 to 160 meters. On the higher frequency bands the oscillator is temperature controlled. Provision is made for optional crystal control. The unit actually is comprised of two v.f.o. units in a common cabinet, with both being driven by the same dial and both deriving power from the same power pack.

## Construction

The exciter unit was constructed on a plate of dural, 5/32" x 10" x 17", and this plate is screwed down to a cast-aluminum sub-chassis, the whole combination making for very rigid construction. In these days of national

Under-chassis view. Each section of the three-gang selector switch has two circuits or poles. Five of the six available circuits are used. Observe the rigid wiring and the practice of "nailing things down."



### COIL DATA

$L_1$—34 turns no. 26 enam., spaced twice diameter of wire on 1½" dia. ceramic form, tapped 8 turns from ground end. Heater coil $L_2$ consists of 8 turns no. 18 interwound at ground end.

$L_3$—51 turns no. 26 on 1½" form; link 7 turns at ground end.

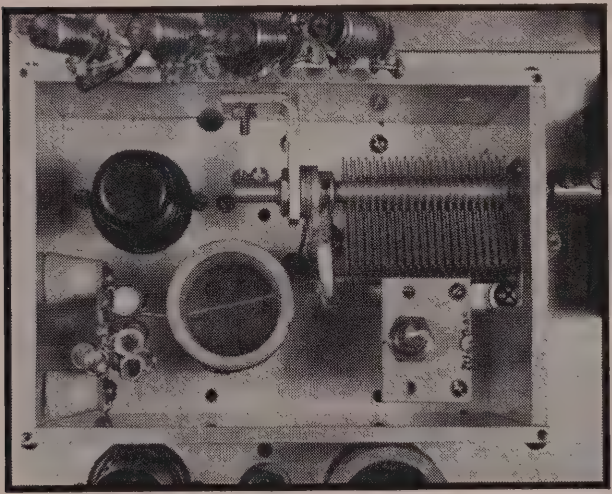
$L_4$—27 turns no. 26 on 1⅛" dia. form; link 3 turns at ground end.

$L_5$—20 turns no. 26 enam., spaced twice diameter of wire on 1⅛" dia. form, tapped 5 turns from ground end. Heater coil $L_6$ consists of 5 turns no. 18 interwound at ground end.

$L_7$—45 turns no. 24 on 1⅛" dia. form.

$L_8$—18 turns no. 22 on 1⅛" dia. form; link 3 turns at ground end.

$L_9$—10 turns no. 22 on 1⅛" dia. form; link 3 turns at ground end.



Looking down into the compartment holding the oscillator for the low frequency channel. The ceramic form is screwed solidly to the chassis, though it appears here to be a plug-in form.

emergency, with aluminum and dural hard to obtain, a cadmium-plated steel chassis can be used to great advantage instead of the dural.

The shields for the electron-coupled oscillators were made of the same material as the chassis plate and front panel. The shield boxes were made by cutting sheet dural into rectangles of the proper size and then drilling and tapping them to take 4-48 screws ½" long. The high-frequency e.c.o. box was lined with some ⅛" asbestos, which was easily obtained from a local hardware store. The sizes of the shield boxes are not at all critical, and these can be made large enough to hold the components of each oscillator. The important thing is to have complete shielding of the oscillators, because otherwise serious modulation will be induced into the carrier.

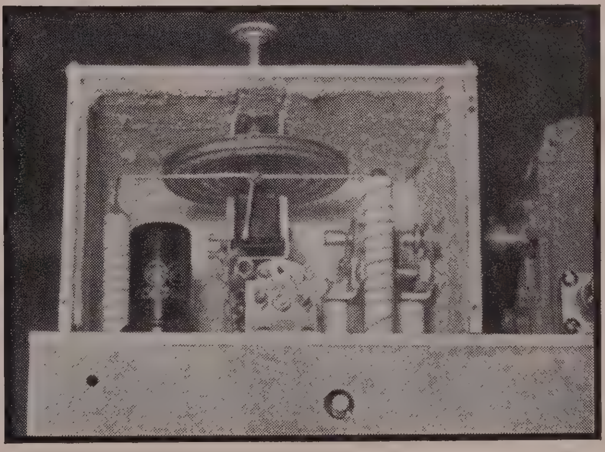
The coils were wound on conventional ceramic coil forms and fixed permanently in place. The leads from the coils were brought through holes in the chassis and terminated on square pieces of polystyrene about 1" x 1" x ⅛". All connections to the coils are made on rivet lugs mounted in the pieces of polystyrene.

A word of caution should be inserted here as to the mounting of the oscillator tuning condensers. These condensers should be mounted carefully so that their shafts are axially in line with the shafts on the dial driving unit. If these condensers are out of line, serious overloading of the dial driving mechanism will result and backlash will occur.

## Power Supply

D.c. voltage for the exciter is obtained from two power supplies, one delivering 300 volts at 150 ma. and the other 210 volts at 50 ma. The higher voltage supply is used on all stages except the two e.c.o.'s and the high-frequency crystal oscillator, these three tubes getting plate voltage from the voltage-regulated 210 volt d.c. supply. Conventional filtering systems are used on both supplies.

A relay is incorporated in series with the two positive leads to the exciter. This relay is a double-pole, single-throw, 110-volt a.c. device,



Interior of the compartment housing the oscillator for the high frequency channel (20- and 40-meter output). This view was taken from the front of the exciter, with the front panel removed. Observe the wafer type thermostat, the asbestos insulation cemented to the inside walls of the compartment, and the two heater elements.

[*Continued on Page 81*]

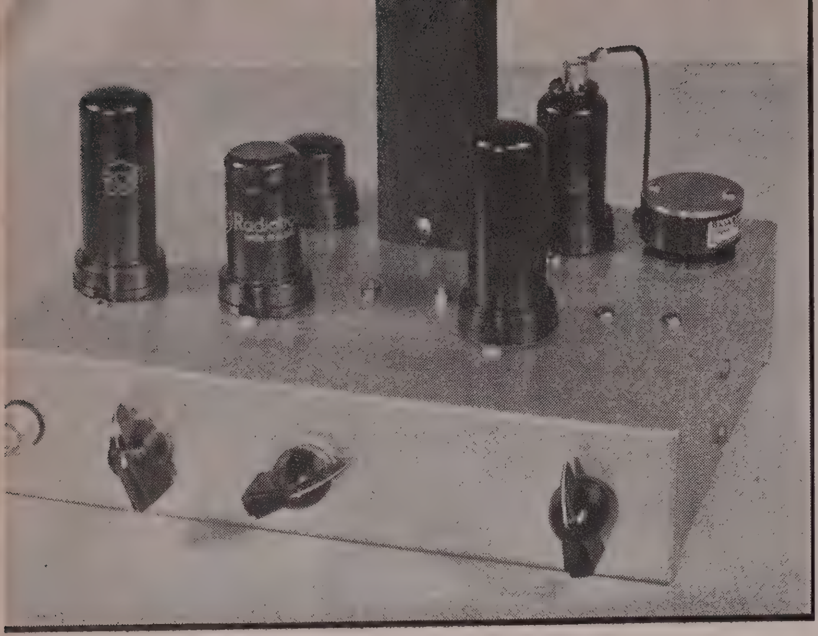


Figure 1.
This unit gives 40-meter f.m. output suitable for exciting a transmitter operating in the new 10-meter f.m. band. The average output frequency is held constant by a crystal oscillator and a frequency-correcting circuit.

# F.M. FOR TEN

By LEIGH NORTON,* W6CEM

Now that 10-meter f.m. has at last become a reality, some f.m. equipment for use on that band would seem to be in order. The two units to be described in the following article are frequency-modulated exciters which may be used with any present c.w. or amplitude-modulated 'phone transmitter which has sufficient frequency multiplication to reach the 10-meter band from their output frequencies. If the present transmitter is amplitude modulated, the a.m. equipment should be disconnected when f.m. is being used, of course.

Since the present f.m. regulations simply call for "stabilized" f.m. transmitters, there is no definite requirement in the amount of stability which the f.m. transmitter must have. The inference from the regulations is that the transmitter should consist of something better than an amplitude-modulated self-excited oscillator, in which f.m. is produced by incidental frequency modulation which accompanies the amplitude modulation. Either of the exciters described below will meet the present regulations, and each should be easily capable of conforming with any future regulations in regard to stability.

The first exciter to be described is of the conventional reactance-tube modulated oscillator type, with the addition of a crystal-controlled stabilizing circuit. The second exciter, which will be of interest to those interested in high-quality f.m., is of the phase-modulated type, and is directly crystal controlled.

## REACTANCE-TUBE EXCITER

The unit seen in figures 1 and 2 provides about 5 watts of frequency-modulated output on the 40-meter band. It consists of a 6F6 e.c.o. operating with its grid circuit on 80 meters and the plate circuit on 40 meters, a 6SJ7 reactance-tube modulator, 6N7 two-stage speech amplifier, and a stabilizing circuit using a 6K8 converter and a 6H6 discriminator.

The basic theory of the reactance-tube circuit should by now be familiar to all amateurs. However, by way of recapitulation, it might be said that the reactance-tube plate-cathode circuit is tied across the oscillator tank circuit and is made to appear as a reactance by exciting the grid with r.f. which is 90 degrees out of phase with the r.f. at its plate. When the amplification of the reactance tube is made to change, by varying the grid bias, the effective plate-cathode reactance changes, and the oscillator frequency likewise changes. When the bias is varied at an audio rate, by applying audio voltage to the grid, the oscillator frequency varies back and forth at an audio rate, and thus frequency modulation is produced.

*Eitel-McCullough, Inc., San Bruno, Calif.

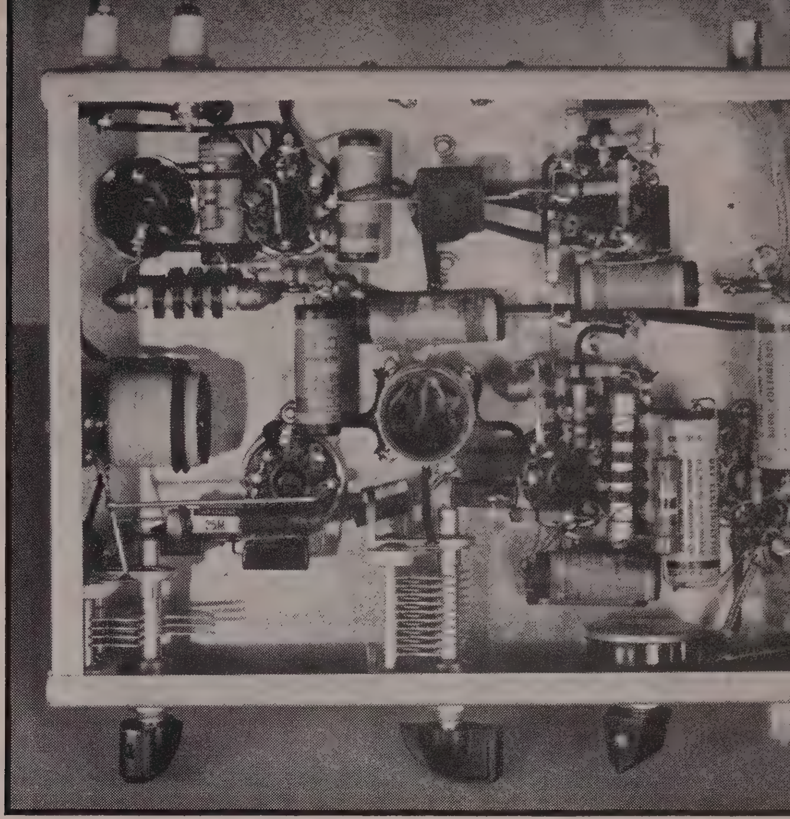


Figure 2.
Under the chassis of the stabilized f.m. exciter. In this view the exciter proper is at the bottom, while the stabilizing circuit is at the top. Note the use of shielded wire for grid leads in the audio circuits. The location of the parts is described in the text.

## Stability

It is apparent that if a change in the operating conditions of the reactance tube will change the oscillator frequency, there is no object in trying to maintain more than an ordinary amount of stability in the oscillator itself. We can build as excellent an oscillator as we please, but the minute we tie the reactance tube across the frequency-controlling tank the stability depends not upon the oscillator but upon the reactance tube. To make matters more difficult, an extremely stable oscillator is exactly what is not needed for f.m. purposes, since we want to be able to vary the frequency of the oscillator easily. A voltage-regulated power supply can be used to maintain constant voltage on the oscillator-modulator combination, of course, but this will not take care of frequency changes due to changes in loading, tube heating, or ambient temperature variation.

What is needed, then, is an arrangement to stabilize the oscillator against frequency changes occurring from any cause whatsoever. In this unit such stabilization is provided by the a.f.c. loop comprised of the 6K8 crystal oscillator-converter, the 6H6 discriminator, and the 6SJ7 reactance tube. The a.f.c. circuit operates so as to hold the f.m. oscillator at a constant difference in frequency from the crystal oscillator. A small portion of the oscillator output is fed to the 6K8 mixer-section grid, where a crystal is used in a Pierce circuit in the 6K8 oscillator section. The difference between the crystal and f.m. oscillator frequencies appears at the 6K8 plate, and this difference frequency is applied through the discriminator transformer, IFT, to the discriminator.

As long as the difference frequency is the same as the frequency to which IFT is tuned, the discriminator output voltage between the top of $R_{12}$ and ground is zero. Should the f.m. oscillator shift slightly, however, the difference frequency changes from the resonant frequency of IFT, and a voltage appears between the top of $R_{12}$ and ground. This voltage will be either positive or negative, depending upon the direction of the frequency shift. The discriminator output voltage is applied, through $R_{11}$ and $R_{18}$, as bias on the reactance tube. This bias causes the reactance tube to change the oscillator frequency back toward the frequency which will give zero discriminator output voltage.

Since the discriminator is nothing but a conventional f.m. detector, it also reproduces the audio modulation in addition to the d.c. "frequency correction" voltage. To prevent the audio from acting on the reactance tube, and thus cancelling out the desired f.m., an R-C filter, $R_{11}$-$C_{16}$, is used betwen the discriminator and the reactance tube. The audio may be used for monitoring purposes, however, by connecting a pair of headphones or the input of an amplifier to jack J (figure 3).

In practice the a.f.c. circuit has proven most satisfactory. Changing the plate voltage on the entire unit from 300 to 200 volts caused a frequency change of 4 kc. on the output frequency (7-Mc. band) without the stabilizing circuit. With the stabilizing arrangement operating, however, the same change in voltage caused the frequency to shift less than 50 cycles. Actually, of course, the stabilization can never be perfect, because it is necessary to have a slight change in frequency remaining to produce the correction voltage. The improvement effected by the a.f.c. circuit is most certainly worth while, however.

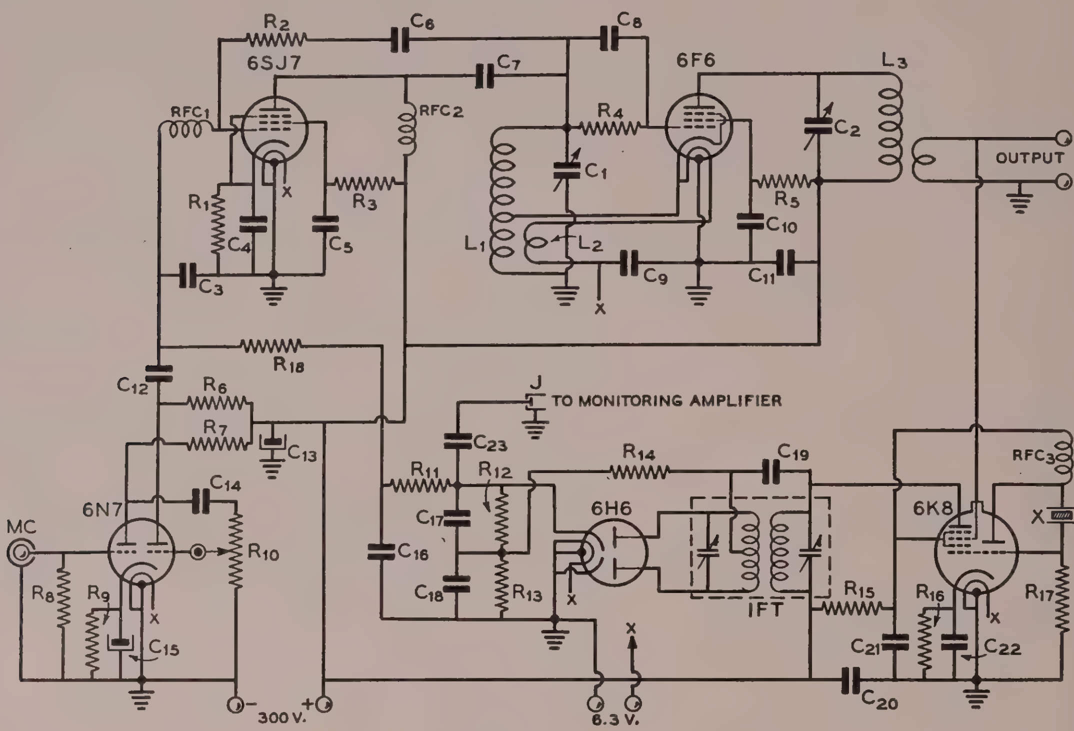



Figure 3.
STABILIZED F.M. EXCITER DIAGRAM.

$C_1$—140-μμfd. midget variable
$C_2$—50-μμfd. midget variable
$C_3$—.0001-μfd. mica
$C_4$—.01-μfd. 600-volt tubular
$C_5$—.25-μfd. 600-volt tubular
$C_6$, $C_7$—.005-μfd. mica
$C_8$—.0001-μfd. mica
$C_9$, $C_{10}$, $C_{11}$—.005-μfd. mica
$C_{12}$—.01-μfd. 600-volt tubular
$C_{13}$—8-μfd. 450-volt electrolytic
$C_{14}$—.01-μfd. 600-volt tubular
$C_{15}$—25-μfd. 25-volt electrolytic
$C_{16}$—.05-μfd. 600-volt tubular
$C_{17}$, $C_{18}$—.0001-μfd. mica
$C_{19}$—.0005-μfd. mica
$C_{20}$, $C_{21}$, $C_{22}$, $C_{23}$—.05-μfd. 600-volt tubular
$R_1$—500 ohms, ½ watt
$R_2$, $R_3$, $R_4$—50,000 ohms, ½ watt
$R_5$—25,000 ohms, 2 watts
$R_6$, $R_7$—250,000 ohms, ½ watt
$R_8$—1 megohm, ½ watt
$R_9$—1500 ohms, ½ watt
$R_{10}$—500,000-ohm potentiometer
$R_{11}$—500,000 ohms, ½ watt
$R_{12}$, $R_{13}$—100,000 ohms, ½ watt
$R_{14}$—50,000 ohms, ½ watt
$R_{15}$—30,000 ohms, ½ watt
$R_{16}$—300 ohms, ½ watt
$R_{17}$—50,000 ohms, ½ watt
$R_{18}$—500,000 ohms, ½ watt
$RFC_1$, $RFC_2$, $RFC_3$—2½ mhy.
IFT—465-kc. "output" i.f. trans. with center-tapped secondary
$L_1$—27 turns of no. 22 d.c.c. close-wound on 1" dia. form, tapped at ninth turn
$L_2$—9 turns of no. 22 d.c.c. over bottom end of $L_1$
$L_3$—25 turns of no. 22 d.c.c. close-wound on 1" dia. form. 2-turn link over "cold" end.
X—Crystal near 7000 kc. for 5- and 10-meter operation, near 7500 kc. for 2½-meter operation

## The Audio End

The speech amplifier consists simply of a single 6N7 as a two-stage resistance-coupled amplifier. Output from the speech amplifier is fed to the reactance tube grid through $C_{12}$. $R_{18}$ is the normal grid-return resistor for the reactance tube, and in the absence of the stabilizer it would be returned directly to ground. $R_{18}$ has been made somewhat smaller than usual to prevent building up excessive reactance-tube bias from the small amount of grid current which flows. Any of the ordinary crystal or high-impedance dynamic microphones will supply adequate input for the speech amplifier.

## Oscillator-Modulator Section

A 6F6 in a conventional e.c.o. circuit serves as the oscillator. To eliminate heater hum troubles, one side of the heater is tied to the cathode, and the other side is run to the hot side of the filament supply through $L_2$, which is closely coupled to the cathode-to-ground portion of $L_1$. The grid circuit has a moderate amount of tank capacity, while the plate circuit

is rather low-C. With 300 volts on the plate the oscillator provides an output of around 5 watts on 40 meters.

The reactance-tube frequency modulator is quite conventional, and needs no detailed comment. The phase-shifting network is formed by $R_2$ and the stray capacity between grid and ground, including the capacity across $RFC_1$. Condensers $C_6$ and $C_7$ are merely blocking condensers which isolate the d.c. voltages.

## Converter-Discriminator

The need for a separate crystal oscillator stage is eliminated by using a 6K8 as a combined mixer-oscillator. The 6K8 triode section makes an excellent Pierce oscillator, even with 40-meter crystals. The oscillator circuit is just about the ultimate in simplicity, requiring only the crystal, one r.f. choke and one resistor. Grid excitation for the mixer is obtained from the ungrounded side of the oscillator output link.

A standard center-tapped "output" i.f. transformer is used between the converter and discriminator. When used with rather high values of discriminator load resistors, this transformer provides a good discriminator voltage-frequency characteristic, thus allowing the frequency-correction network to operate effectively for small changes in frequency.

## Construction

There is nothing particularly complicated about the construction of the exciter. Figure 1 shows the top of the chassis, which measures 7 by 9 by 2 inches. The front half of the chassis is given over to the exciter proper, while the frequency-correction section is located at the rear. From left to right, the tubes across the front are: speech amplifier, reactance tube, and oscillator. The crystal is at the right rear, with the converter tube, the discriminator transformer, and the discriminator tube in order toward the left. The front drop of the chassis mounts the microphone connector, gain control, grid tuning control, and plate tuning control.

The bottom view of the chassis, figure 2, shows that the various condensers, resistors, and chokes have been located as convenience dictates. The principal precaution in the under-chassis wiring has been to keep the r.f. wiring well separated from the speech amplifier section, and to mount the oscillator grid and plate coils at right angles to each other.

## Operation

Before placing the exciter into operation, the lead between $R_{18}$ and $R_{11}$ should be disconnected and the "free" end of $R_{18}$ run directly to ground. This allows the exciter to be tuned up without having the stabilizing section complicate the issue. The oscillator may be tuned up in the conventional way; that is, tuning the grid circuit to the desired frequency, and the plate circuit for maximum output. The correct exciter output frequency will be between 7312.5 and 7500 kc., for the 10- or 5-meter f.m. bands. If the unit has been wired correctly, speaking into the microphone will cause the signal to sound pretty awful, when listening on an ordinary a.m. receiver, showing that frequency modulation is taking place. If the receiver is tuned off slightly to one side or the other of the signal peak, however, the modulation should sound normal.

Next, the discriminator section should be tuned. First, however, make sure that the crystal section is oscillating by tuning a receiver to the crystal frequency. The crystal must have a frequency around 7000 kc., to give the proper difference frequency in the mixer plate circuit.

There are several ways of tuning up a discriminator, and the method to be used will depend upon the equipment on hand. Three possible ways will be described: First, if an ordinary amplitude-modulated signal generator is available, the generator should be connected between the 6K8 grid and ground. The lead normally running to the 6K8 grid should be disconnected when this is done, of course. Now a pair of headphones should be connected to the monitoring jack, J, and the signal generator adjusted to produce a modulated signal in the 300- to 500-kc. range. Tuning the generator across its range should reveal a frequency which will give a signal in the phones. When this frequency is found, the primary (plate) trimmer on IFT should be tuned for maximum signal, and the secondary trimmer tuned accurately for a "dip" in the strength of signal. When the transformer is correctly tuned, detuning the signal generator either way from the resonant point will cause the signal strength to increase.

Another method of tuning the discriminator is to use a high-resistance voltmeter or a v.t.v.m. connected between the top of $R_{12}$ and ground, with the test signal provided either by a signal generator, as above, or by using the exciter's oscillator itself and converting to the discriminator frequency in the 6K8. In either case, the discriminator secondary trimmer should be adjusted to give a zero voltmeter reading, and detuning the oscillator in one direction should give a positive voltage, while detuning in the other direction should give negative voltage. The primary trimmer should be adjusted to give maximum and equal voltage

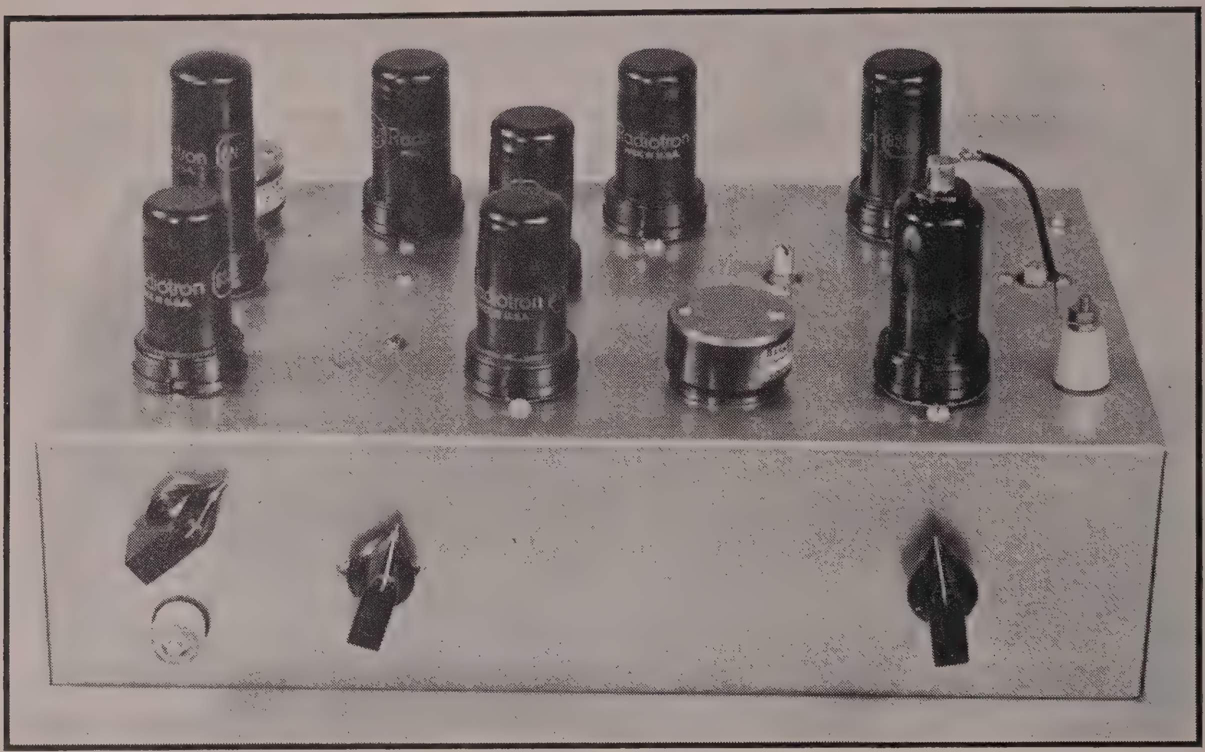


**Figure 4.**
The phase-modulated f.m. exciter. This type of exciter allows f.m. to be produced without the use of a self-controlled oscillator. Receiving tubes and components are used throughout the exciter.

readings for equal departures each side of resonance.

Still another method of tuning the discriminator is to apply an audio signal to the speech amplifier input, either from an audio oscillator or by speaking into the microphone, and again listening to the signal from the monitor output. The exciter oscillator should be tuned slowly until the signal is heard, and then the trimmers on IFT adjusted for maximum signal and greatest fidelity.

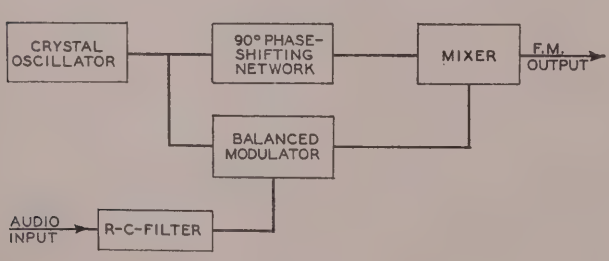



Figure 5.
Block diagram of a phase-modulation circuit. Amplitude-modulated sidebands are combined with a phase-shifted carrier to produce a phase-modulated signal. When the audio input is attenuated directly in proportion to its frequency, the output signal becomes frequency modulated.

Once the discriminator has been tuned, $R_{18}$ may be connected back to $R_{11}$ and the operation of the frequency correcting arrangement checked. Since the required oscillator frequency will be the sum of the discriminator and crystal frequencies, a calibrated receiver should be set at this sum frequency. Now, when the oscillator is tuned close to the point where the receiver is tuned, either one of two things will happen: The oscillator may "lock in," so that its frequency will not change for a rather large change in the setting of $C_1$, or the oscillator may be "thrown" right across the receiver frequency, and no amount of tuning with $C_1$ will give a point where the signal may be tuned to the receiver frequency. The first condition indicates that all is well, while the second shows that the discriminator voltage polarity is incorrect for stabilization. To reverse the discriminator polarity, simply reverse the two plate leads from IFT to the 6H6.

## To Change Frequency

Since the output frequency is equal to the sum of the crystal and discriminator frequencies, it is only necessary to retune the discriminator transformer to change the exciter frequency. The transformer specified has a tuning range of from 255 to 550 kc., so the exciter will cover a range of from 7225 to 7550 kc. with a 7000-kc. crystal.

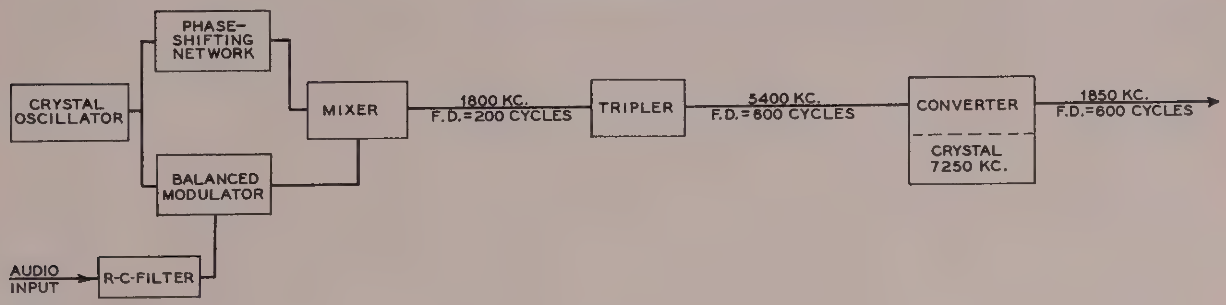



Figure 6.
Block diagram of the complete p.m. exciter. The section shown in figure 5 is followed by a tripler and a frequency converter, which serve to increase the deviation without greatly changing the output frequency.

The deviation may be adjusted to any desired amount by simply changing the setting of the gain control. The maximum deviation should be at least 25 kc. on 10 meters if the unit is operating properly. One of the simplest methods of checking the deviation is to apply a low-frequency modulating signal to the speech amplifier input and observe the width of the band occupied by the resulting f.m. signal. This bandwidth will be very close to twice the deviation. The 60- or 50-cycle line voltage will provide a suitable low-frequency modulating source, after it is reduced to 1 or 2 volts by means of a transformer or voltage divider.

## PHASE-MODULATED EXCITER

The phase-modulation method of obtaining frequently modulation deserves more attention in amateur circles than it has received in the past. This method, which is sometimes known as the "Armstrong system" allows f.m. to be obtained with a directly crystal-controlled signal, there being no need for a self-controlled oscillator or reactance tube.

### Theory

The amount of f.m. produced by phase modulation (p.m.) depends upon the amount of phase shift and the *rate of change of phase.* A shift in the phase of the r.f. carrier will cause the effective frequency to change as long as the phase is changing. As soon as the phase stops changing the frequency returns to its original value. The faster the phase is changed, the greater is the frequency shift. When the phase is changed at an audio rate, the change is obviously most rapid at the high audio frequencies, and, for a given amount of phase shift, the amount of frequency modulation increases directly with the modulation frequency. To make the frequency modulation independent of the audio frequency and proportional only to the amplitude of the modulating signal, a simple R-C filter is inserted in series with the audio input to the phase modulator. This filter causes the amount of phase modulation to decrease linearly as the modulation frequency increases, thus giving a true frequency-modulated signal.

Phase modulation is obtained by amplitude modulating a constant-frequency carrier, separating the a.m. sidebands from the carrier, shifting the phase of either the carrier or the sidebands by 90 degrees, and recombining the sidebands with the unmodulated carrier. All of this can take place at very low power levels, where receiving tubes and components can be used. A block diagram of the basic arrangement is shown in figure 5. The phase-shifting network is shown in the excitation lead to the mixer stage, but it might just as well be in the input or output lead of the balanced modulator stage, the only requirement being that there should be a 90-degree phase shift between the sidebands and the carrier.

The balanced modulator stage shown in figure 5 may consist simply of two tubes with their grids in push-pull and plates in parallel, with audio fed into another pair of grids in push-pull. When there is no audio signal applied to the modulator, the push-pull grid excitation is cancelled out in the parallel plate circuit, and the modulator does not give any output. However, when an audio signal is applied to the modulator, the stage is thrown out of balance at an audio rate, and the sidebands, minus carrier, are produced across the plate tank circuit. When these sidebands are combined with phase-shifted carrier, a phase-modulated signal is produced.

The principal disadvantage of phase modulation is that only a small amount of frequency modulation can be produced before the distortion becomes objectionable. In broadcast work the maximum deviation is limited to approximately one-third the lowest modulating fre-

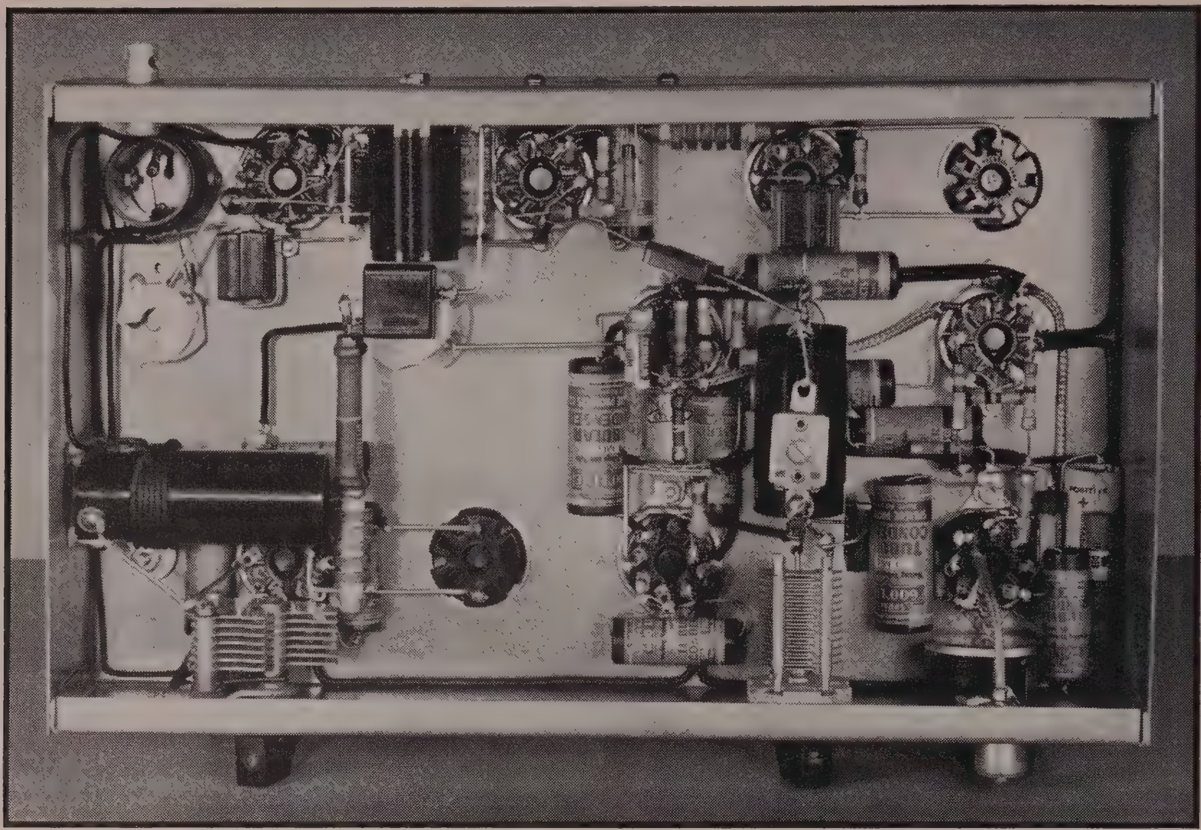


Figure 7.
Under-chassis view of the p.m. exciter. In this view the speech section is seen at the right, with the r.f. section running along the top and ending up in the lower left corner. The balanced modulator stage occupies the center portion of the chassis.

quency at which the signal is to be fully modulated. Since the lowest modulating frequency is usually around 30 cycles, the maximum deviation is only 10 cycles, and a great deal of frequency multiplication is necessary to give a reasonable amount of deviation on the output frequency. The lowest modulation frequency is the limiting factor in the amount of p.m. which can be used because the previously mentioned R-C network reduces the *phase modulation* as the frequency is increased, thus causing the modulation to be greatest at the lowest frequency.

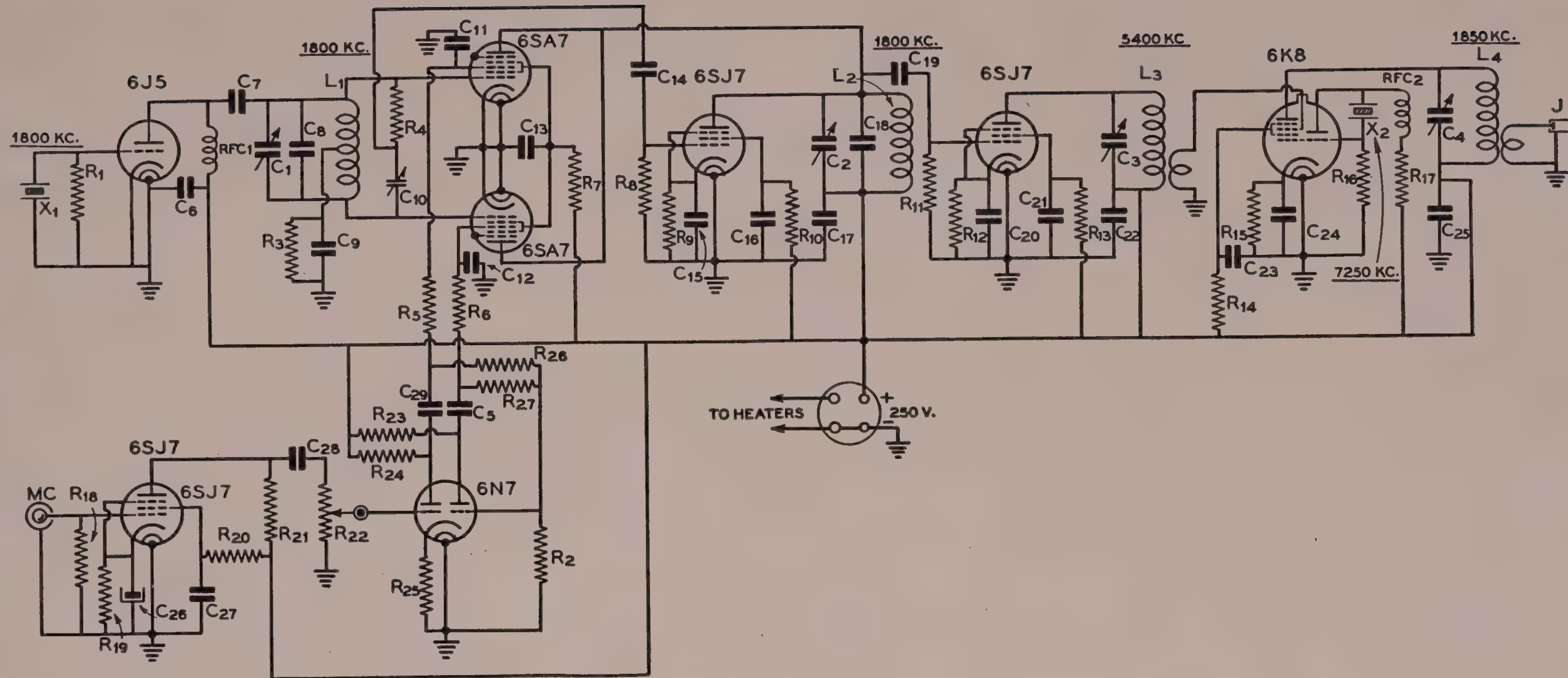
For amateur, or other voice-communication work, this disadvantage of the phase-modulation method becomes less important. For one thing, the male voice does not often produce maximum-intensity peaks below 400 cycles, so that we can take 400 cycles as the lowest frequency at which full modulation will occur. Secondly, the maximum permissible deviation may be increased to one-half, rather than one-third, of the lowest frequency at which maximum modulation occurs, thus giving a maximum deviation of 200 cycles. This will cause the distortion at 400 cycles to be near 8 per cent at full modulation, but the distortion will drop rapidly at higher frequencies, so the distortion over the complete audio range will not be objectionable. Another point in favor of the phase-modulation method for voice-communication work is the known superiority of narrow-band f.m. over the wide-band variety where the transmission of intelligence is concerned, thus further reducing the amount of frequency multiplication which must be used.

When the above factors are taken into consideration, it is found that the phase-modulation method of obtaining f.m. is quite satisfactory for communication work. Figure 6 shows a block diagram of the unit illustrated in figures 4 and 7. The first three stages are the same as shown in figure 5. These three stages produce an f.m. signal having a maximum deviation of 200 cycles. The signal frequency is 1800 kc. Frequency multiplication of this signal to reach the 10-meter band would give an increase in deviation of 16 times, making the maximum deviation on the output frequency 3.2 kc.

A deviation of 3.2 kc. on 10 meters probably is enough for narrow-band work, but where wide-band receivers are likely to be encountered it is wise to have more deviation available, so the deviation-increasing circuit seen at the right of figure 6 is included in the exciter.

Figure 8.

PHASE-MODULATED F.M. EXCITER.




C1, C2—75-μμfd. midget variable
C3—50-μμfd. midget variable
C4—100-μμfd. midget variable
C5—.05-μfd. 600-volt tubular
C6, C7—.01-μfd. 600-volt tubular
C8—.0001-μfd. mica
C9—.05-μfd. 600-volt tubular
C10—3-30-μμfd. mica trimmer
C11, C12—.01-μfd. 600-volt tubular
C13—0.1-μfd. 600-volt tubular
C14—.003-μfd. mica
C15, C16, C17—.01-μfd. 600-volt tubular
C18—.0001-μfd. mica
C19—.0005-μfd. mica
C20, C21, C22, C23—.01-μfd. 600-volt tubular
C24—.003-μfd. mica
C25—.01-μfd. 600-volt tubular
C26—10-μfd. 25-volt electrolytic
C27—0.1-μfd. 600-volt tubular
C28—.01-μfd. 600-volt tubular
C29—.05-μfd. 600-volt tubular
R1, R2—100,000 ohms, 1/2 watt
R3—10,000 ohms, 1/2 watt
R4—5000 ohms, 1/2 watt
R5, R6—3000 ohms, 1/2 watt
R7—10,000 ohms, 5 watts
R8—100,000 ohms, 1/2 watt
R9—300 ohms, 1/2 watt
R10—50,000 ohms, 1/2 watt
R11—100,000 ohms, 1/2 watt
R12—300 ohms, 1/2 watt
R13, R14—50,000 ohms, 1/2 watt
R15—300 ohms, 1/2 watt
R16, R17—50,000 ohms, 1/2 watt
R18—2 megohms, 1/2 watt
R19—500 ohms, 1/2 watt
R20—1 megohm, 1/2 watt
R21—250,000 ohms, 1/2 watt
R22—500,000-ohm potentiometer
R23, R24—100,000 ohms, 1/2 watt
R25—2000 ohms, 1/2 watt
R26, R27—250,000 ohms, 1/2 watt
RFC1, RFC2—2 1/2 mhy.
MC—Microphone connector
J—Auto-type connector
L1, L2—45 turns of no. 24 enam. close-wound on 1" dia. form. L1 center-tapped
L3—28 turns of no. 24 enam. close-wound on 1" dia. form. Secondary is 6 turns of hook-up wire wound over "cold" end.
L4—100 turns of no. 24 enam. close-wound on 1" dia. form. Link is 6 turns of hook-up wire wound over "cold" end.
X1—Crystal near 1800 kc.
X2—Crystal near 7250 or 7000 kc., see text

This portion of the circuit takes the 1800-kc. f.m. signal through a tripler to 5400 kc., where the deviation is also tripled to a maximum of 600 cycles. Output from the tripler is applied to the mixer section of a 6K8. The oscillator section of the 6K8 uses a 7250-kc. crystal in a Pierce circuit, and the difference between 5400 and 7250 kc., or 1850 kc. appears across the 6K8 plate tank circuit. The signal at the plate of the 6K8 retains the 600-cycle deviation, so the deviation is increased three times with but a small change in frequency. When the 1850-kc. output is multiplied 16 times to reach the 10-meter f.m. band, the maximum deviation becomes 9.6 kc., which is more than adequate for narrow-band f.m. and is also sufficient for medium-bandwidth communication work.

In passing it might be mentioned that it is quite possible to dispense with the 7250-kc. crystal by using a quadrupler directly from the 1800-kc. oscillator to excite the converter's oscillator grid. This would make the difference frequency at the 6K8 plate equal to the crystal frequency, since the difference would be that between the third and fourth harmonics of the same crystal. The trouble with this arrangement is that both the original and the deviation-multiplied signals are on the same frequency, which makes it difficult to tell whether or not the exciter is operating properly. Since there is little difference in cost between the additional crystal and the quadrupler stage required for single-crystal operation, the two-crystal arrangement was decided upon for this unit.

## The Circuit

Figure 8 shows the circuit of the p.m. exciter. A 6J5 is used as the 1800-kc. crystal oscillator, which uses a balanced plate tank circuit. Output from this tank circuit is fed directly to the two no. 1 grids of the 6SA7's, which act as the balanced modulator. Another output connection from the oscillator stage is taken from the junction of $R_4$ and $C_{10}$, which together form the phase-shifting network. When the reactance of $C_{10}$ is equal to the resistance of $R_4$, the output between the junction and ground is 90 degrees out of phase with the energy at the ends of $L_1$. The phase-shifted output is fed through $C_{14}$ to the grid of the 6SJ7 mixer stage. The mixer plate tank circuit also acts as the plate circuit for the balanced modulator, and here the sidebands are combined with the phase-shifted carrier to form a phase-modulated signal.

The audio section of the exciter consists simply of a 6SJ7 resistance coupled to a 6N7 self-balancing phase inverter. Output from the 6N7 plates is fed through the R-C networks formed by $R_5$-$C_{11}$ and $R_6$-$C_{12}$ to the no. 3 grids of the two 6SA7's. The gain of the audio section is ample for any ordinary crystal or high-impedance dynamic microphone.

Following the 6SJ7 mixer are the two stages which serve to increase the deviation. The first of these stages is a 6SJ7, which acts as a conventional frequency tripler to an output frequency of 5400 kc. From this stage the output is inductively coupled to the 6K8 mixer grid. The 6K8 oscillator section uses the aforementioned Pierce crystal oscillator, and the 1850-kc. difference frequency is taken from the plate tank circuit, $L_4$-$C_4$.

## Construction

Figure 4 shows the above-chassis layout. Here the 6SJ7 and 6N7 speech amplifier stages and the 1800-kc. crystal are seen in a row from front to back at the left edge of the 12 by 7 by 3-inch chassis. To the right of the crystal is the 6J5 oscillator tube, with the two 6SA7's slightly to its right and toward the front of the chassis. Next is the 6SJ7 mixer, at the rear of the chassis, with the tripler tube to its right. The 6K8 converter is at the right front of the chassis, with the 7250-kc. crystal to its left.

On the front drop of the chassis are, from left to right, the microphone connector and gain control, crystal plate tuning, and converter plate tuning. The other two tank condensers are mounted with their shafts projecting through the chassis top, since these are adjusted by a screwdriver in the initial tuning up and then left at the correct setting. The crystal plate tuning control can also be located on the chassis top, if desired, since it, too, needs to be adjusted only in the initial tuning.

Underneath the chassis the components for each stage are grouped around their respective tubes. Figure 7 shows the underchassis layout. In this view the speech section is seen at the lower right, with the low-frequency crystal socket at the top right. The r.f. section progresses along the top from right to left, ending up with the 6K8 converter stage at the lower right. The balanced-modulator stage is just to the right of the center of the photograph, and the crystal stage plate coil may be seen to the right of the 6SA7 sockets.

## Tuning Up

Before tuning up the exciter it is wise to remove the 6SA7's from their sockets, since these tubes receive their bias from the grid current through $R_3$, and loss of excitation during the

[*Continued on Page 82*]

# A Self-Synchronous DIRECTION INDICATOR for Rotary Beam Antennas

By F. ALTON EVEREST*

During the past few years, amateur interest has been running high on rotary beam antennas. And the fact that they are so widely used today is good evidence of the fact that they are really effective. As the beam antenna is usually located in a spot advantageous as a position for a radiator, and not necessarily where it can be seen from the operating position, some means of remote direction indication is quite necessary. There have been several excellent descriptions of direction indicators[1, 2, 3,] but they all carry with them some of the following disadvantages:

1. Complexity at indicating end
2. Complexity at actuating end
3. Not automatic
4. Accuracy varies with voltage applied
5. Too many wires between antenna and indicator
6. Not foolproof

Let's take a tip from the new d.c. "selsyn"** aircraft instruments and make a rotary indicator which is the very essence of simplicity at both the actuating and the indicating ends and yet has the very great advantage of indicating continuously, not step by step.

## Operation of the D.C. Selsyn

The principle of operation is very simple and is illustrated in figure 1. The actuator consists of a continuous resistance element tapped at three equally spaced points. The two sliding arms on the actuator rheostat are just 180 degrees apart and separate connections are brought out for each one. The indicator is, in effect, a Gramme ring winding which will be familiar to the old-timers who knew their electrical equipment a decade or more ago. It consists of a ring of magnetic material upon which is wound three coils which may be joined and considered a single coil, tapped at three points. Incidentally, this single-coil concept gives the right polarity of the coils without any heavy thinking being necessary, too. Within the Gramme-ring winding of the indicator, a permanent magnet is placed. In the aircraft or industrial applications, a pointer which sweeps over a dial is affixed to the magnet, the pointer and dial being the only parts visible. In our case, let's just use the simplest and cheapest indicator, namely a pocket compass.

When a current passes through a coil of wire, a magnetic field is set up along its axis. Which end of the coil is north depends upon the *direction* of current flow, and the strength of the

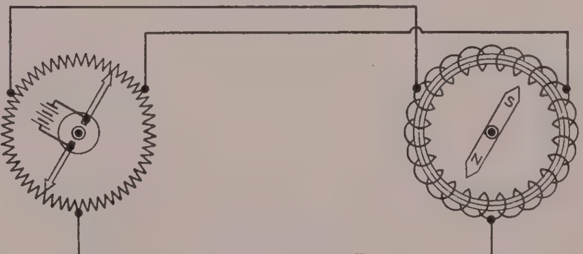



Figure 1. Essentials of the d.c. selsyn.

*Oregon State College, Corvallis, Oregon.

**"Selsyn" is a General Electric trademark for self-synchronous devices.

1."Direction Indicator for Rotaries", Waller, RADIO, Oct. 1938, p. 16.

2."A Cathode-Ray Indicator for the Rotary Beam," MacAllister, RADIO, July 1941, p. 30.

3."Some Hot Ideas on Direction Indicators for Rotatable Antennas", *QST*, July 1938, p. 48.

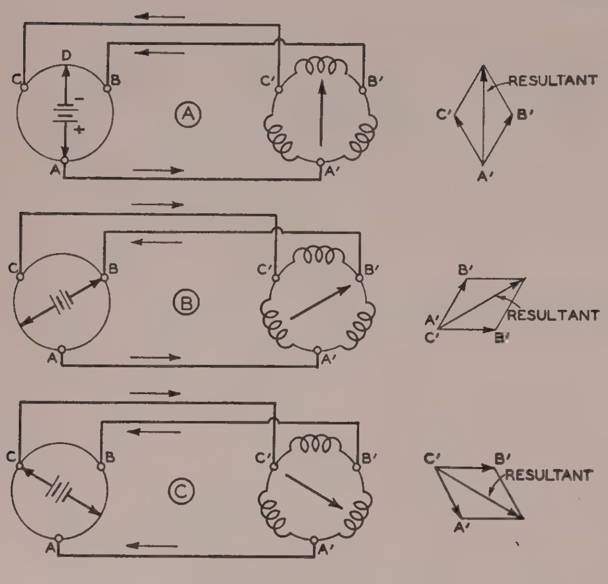



Figure 2. Simplified vector analysis of the manner in which the d.c. selsyn operates.

magnetic field set up is determined solely by the *amount* of current flowing. Surely this is a magnetic vector, for a vector has magnitude and direction, and as we have three coils, we will have three magnetic vectors combining to give a resultant across the Gramme ring for any position of the actuator arms. The compass needle, of course, can't see the three components but only feels the influence of the resultant and proceeds to line itself up with it.

The three sketches of figure 2 show how these magnetic components combine for three positions of the actuator arm. In figure 2 (A), the current in the actuator resistance will flow from point A up both sides and back into the battery through point D. A certain IR drop will exist across A-B which will cause a current to flow through coil A′-B′ producing a magnetic vector shown on the vector diagram. A current of the same magnitude flows through coil A′-C′, but due to the physical orientation of its axis, its magnetic component will be in a direction different from A′-B′. No current will flow in the coil C′-B′ because the IR drops C-D and B-D are equal and opposite on the actuator resistance. Therefore, the resultant will be the vector sum of the two components A′-C′ and A′-B′, and it will point in the same direction as the actuator arm.

In figure 2 (B), the actuator arm has been moved, causing different voltages to be applied to all the coils but A′-B′. Zero voltage now exists on coil A′-C′ and, therefore, points A′ and C′ are at the same potential. The two magnetic components A′-B′ and C′-B′ now combine to form the resultant which has followed the actuator arm around. The compass needle follows the resultant magnetic field and, hence, the actuator arm. Figure 2 (C) carries the process one step further, and we see that no current flows in coil A′-B′ this time, and the compass needle is still in step with the actuator arm making it truly a "self-synchronous" device. As the actuator arm is rotated, the current in a given coil goes through a reversal cycle, and its contribution to the magnetic resultant does likewise.

## The Special Rheostat

There has recently been placed upon the market a 360-degree direction indicator rheostat intended for this use (Ohmite DR-125). The availability of this rheostat takes the rotary beam indicator about to be described out of the extremely expensive class of aircraft instruments, on the one hand, and the inevitable haywire makeshift on the other, and places the indicator to be described in a price class satisfactory to anyone who can afford a beam antenna.

## Winding the Indicator Coil

The Gramme ring coil is shown in the photograph of figure 3. It is wound on a ¾-inch section of 3-inch (length) pipe which has a wall thickness of around ¼ inch. After the sharp edges were taken down on a grinder, a layer of common ½-inch cotton tape was wrapped on the pipe. The core was then wound with a single layer of no. 28 d.c.c. wire with a shuttle, keeping the winding as even as possible. When completely full, the turns were counted, divided by three, and the three equidistant taps located. At these tap points, a wire was raised carefully, cleaned, and a strip of tinned copper ⅛-inch wide was bent around it and soldered, protecting the other wires by a piece of fiber slipped underneath. The whole coil was then wrapped with a layer of the cotton tape and given a good coat of varnish. The copper strips are held in place by several turns of tape before they are bent up to emerge and form the soldering lug.

The indicator assembly is now complete when a compass is placed within the ring as shown in figure 3. The resourcefulness of the amateur may now come into play in putting these working parts of the indicator together in a novel and convenient form.

## Mounting the Actuator

The actuator rheostat, shown in figure 4, is coupled to the rotatable beam antenna struc-

ture. If there is space beneath, the best method is to tie the shaft and the rheostat together directly, if not, a 1-to-1 belt or gearing arrangement can be used. The rheostat should be mounted inside a water-proof housing of some sort if exposed to the elements, as it, no doubt, will be in most cases. Five wires must extend to the indicating position, two for the d.c. source and three for the indicator connections.

The orientation is accomplished as follows: place the north mark on the compass in the desired position (usually away from the observer), swing the beam antenna until it points north, adjust the actuator rheostat until the compass needle points to the north mark on the compass card, and then tighten the screws coupling the rheostat to the antenna. If the rotary points east and the indicator reads west, merely interchange two wires on the indicator coil.

## Operating Voltages

The action of the indicator described is independent of the voltage applied. A change in voltage does not alter the position of the magnetic vectors, only their magnitude. The higher the voltage, the more positive the action of the indicator. This is limited, however, by the sluggish action at extremely low voltages and the 24-volt d.c. rating on the actuator rheostat. The indicator described works quite well on 6 volts, but the action is fine on 12 volts and very little improvement can be noted by increasing the voltage to 24 volts. At 6 volts, the current drain varies from about 100 to 140 ma., depending upon the setting and the coil resistance. The resistance as measured between any two taps on the indicator rheostat is about 112 ohms, but, of course, this is paralleled by the very low resistance of the Gramme ring, slightly over an ohm.

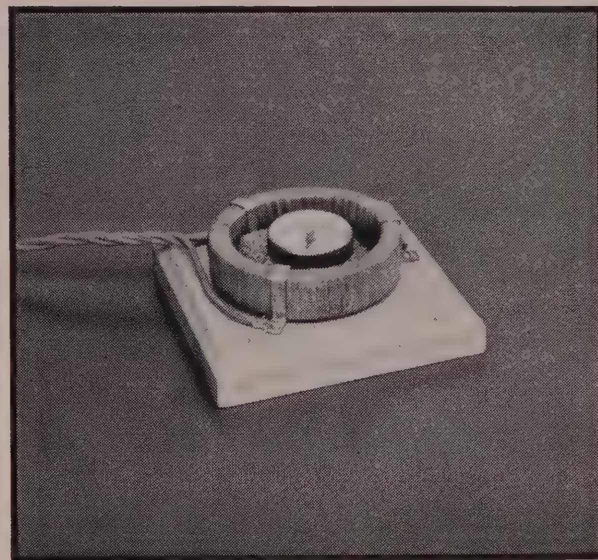


Figure 3. The homemade Gramme ring and dime-store compass which make up the indicator portion of the affair.

## Power Supply

The power can be supplied in a number of ways such as with a dry, battery-charging type of rectifier with some filtering, or a regular low-voltage power pack utilizing thermionic tubes for use for extended periods. For use only when the beam is being adjusted, ordinary flashlight cells or dry cells would give long life.

The method of obtaining power that will appeal to most amateurs, however, is to select a power supply somewhere in the transmitter that is turned on when the beam is in use and insert the direction indicating leads in series with a ground return lead carrying a current of from 150 to 500 ma. The drop across the indicator rheostat for currents of this magnitude will be only about 6 to 20 volts, which in

[*Continued on Page 83*]

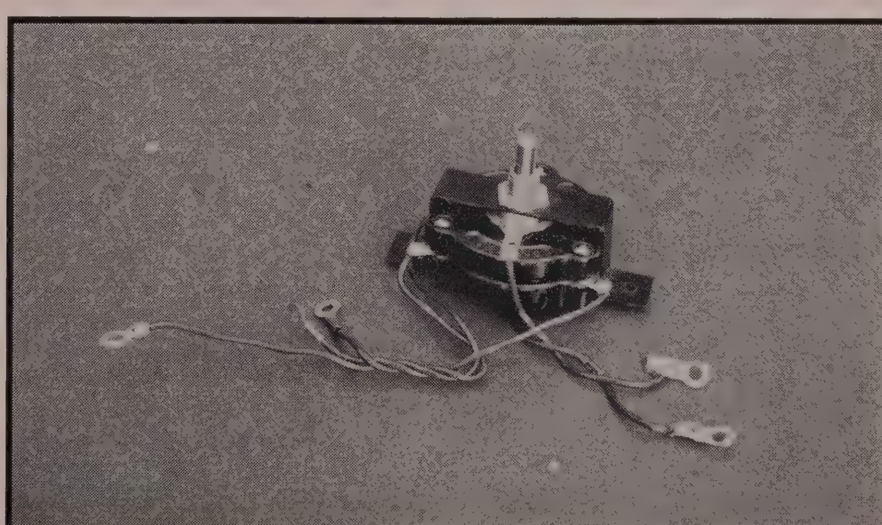


Figure 4. Photograph showing the specially designed actuator rheostat for use with the d.c. selsyn indicator.

# A High-Sensitivity

# VACUUM-TUBE VOLTMETER

By J. D. RYDER,* W9VDE (ex-W8DQZ)

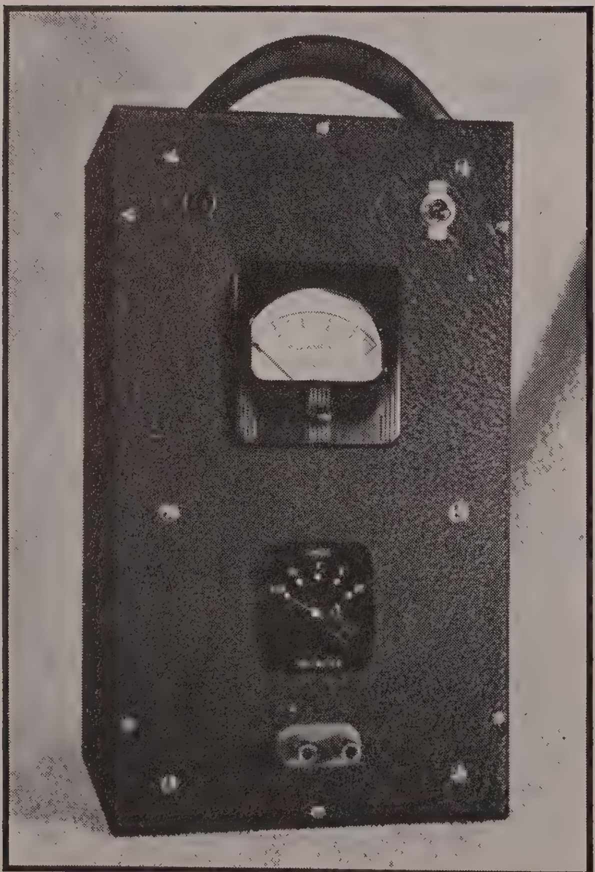


Figure 1. Front view of the v.t. voltmeter. The case is one intended for transceivers. The a.c. switch and pilot are at the top of the panel; the input terminals at the bottom.

To most amateurs a vacuum-tube voltmeter is an instrument—made up of an expensive microammeter and a collection of odds and ends—for which the calibration curve has been lost. In other words the usual vacuum-tube voltmeter is nice to have, expensive to get, and not used much anyway.

This voltmeter is different. It uses no expensive meter, need have no calibration curves, and has such a wide voltage range that it is universally useful and therefore used. While commercial instruments of this type are available, they are usually "dx" as far as an amateur's pocketbook is concerned, yet the circuits required are so straightforward that construction of such a voltmeter is easy and relatively cheap.

First the specifications. The voltmeter shown in figure 1 will cover the audio frequency range of 20 cycles to 25,000 cycles with an accuracy of better than 2 per cent. No radio-frequency coverage, but then a lead pencil is still the simplest and most used r.f. voltmeter.

There are five switch-controlled linear voltage ranges, covering respectively 0-20 millivolts (*yes,* millivolts), 0-0.2 volt, 0-2 volts, 0-20 volts, and 0-200 volts. This arrangement of ranges gives a 10 per cent overlap at the bottom of every range—a very great convenience. The indicating meter is an ordinary 0-1 milliampere meter, 3-inch size. A larger meter with a more readable scale might be used if

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the budget permits. Since the voltage ranges are perfectly linear, a simple multiplier is all that is necessary for using the 1-meter scale on the various ranges.

The voltmeter is essentially a multistage feedback amplifier preceding a diode rectifier voltmeter. Figure 1 is a view of the front panel showing on-off switch and pilot light, indicating meter, range control switch, and input binding posts. Since the amplifier overloads at a voltage just slightly above the top of any range, the milliammeter is well protected from the effects of excessive voltage application.

Figure 2 shows the internal construction of the meter, indicating the manner in which the whole unit is mounted on a bent subpanel and suspended by posts from the front panel of the carrying case. The rather peculiar bent subpanel is made from a flat sheet of 1/16″ metal, bent so as to form a channel for mounting the electrolytic by-pass condensers and also to serve as a shield between the input and output stages of the unit. The bending can be easily accomplished with a couple of small boards and an ordinary vise. The first two amplifier stages are mounted on the small shelf on one side of the condenser channel, and the third stage, diode rectifier, and power supply on the larger shelf at the other side of the channel. The input switch and range selection resistors are mounted on the front panel above the condenser bank.

The case used was a standard 6″ x 7″ x 12″ carrying case with handle, and provides ample room without crowding. The electrolytic condensers should be mounted as shown to use the space most efficiently, however. In assembling the condensers in their channel, so arrange them that the positive and negative leads are near the points of the circuit to which they connect, and the proper capacity sizes are at appropriate places.

Figure 3 is a view of the bottom of the assembly, indicating socket location and method of wiring. It was impossible to find some small sockets to fit the RCA 991 neon tubes, so they are soldered directly to the wiring and hang under the power transformer. The rest of the assembly is standard, although someone may want to know what the large spools are around the input stage. They are wire-wound resistors, strongly recommended for use in the input stage circuit.

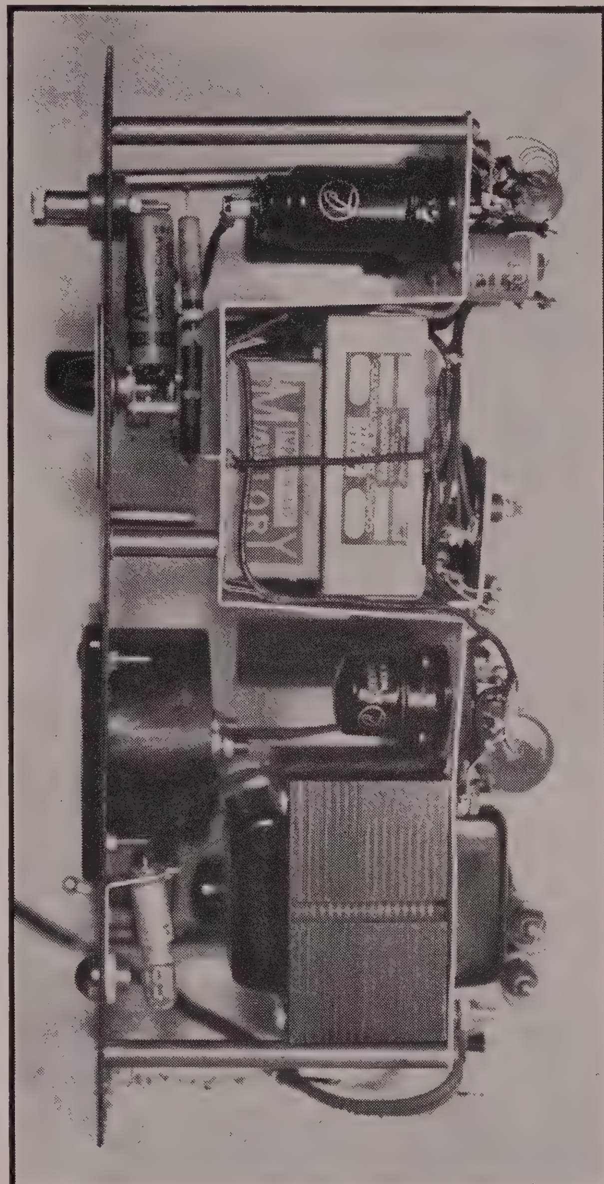


Figure 2. Side view, showing the shape of the chassis. The "hair" wire at the top of the chassis is the feedback resistor R. At the bottom, behind the power transformer, are the two neon bulbs.

## Circuit

The circuit as shown in figure 4 may look complicated. However, closer examination will show it to be merely a three-stage pentode amplifier, with all the little parasitics, banshees, and motorboating devils effectively blacked out by the magic of the little feedback resistor R. The circuit, while using three pentode stages, has a gain equivalent to not much more than one stage, while the constancy of gain, independence of tube or line voltage changes, and general stability increase as the gain is reduced. It should be sufficient to say that when the unit was first turned on, it worked and was within 50 per cent of correct calibration.

The first stage uses a 6J7 tube solely for the reason that we want the input grid connection where the 6J7 has it, on top, giving a short lead from the range switch, and isolation from the other circuits. The second and third stages

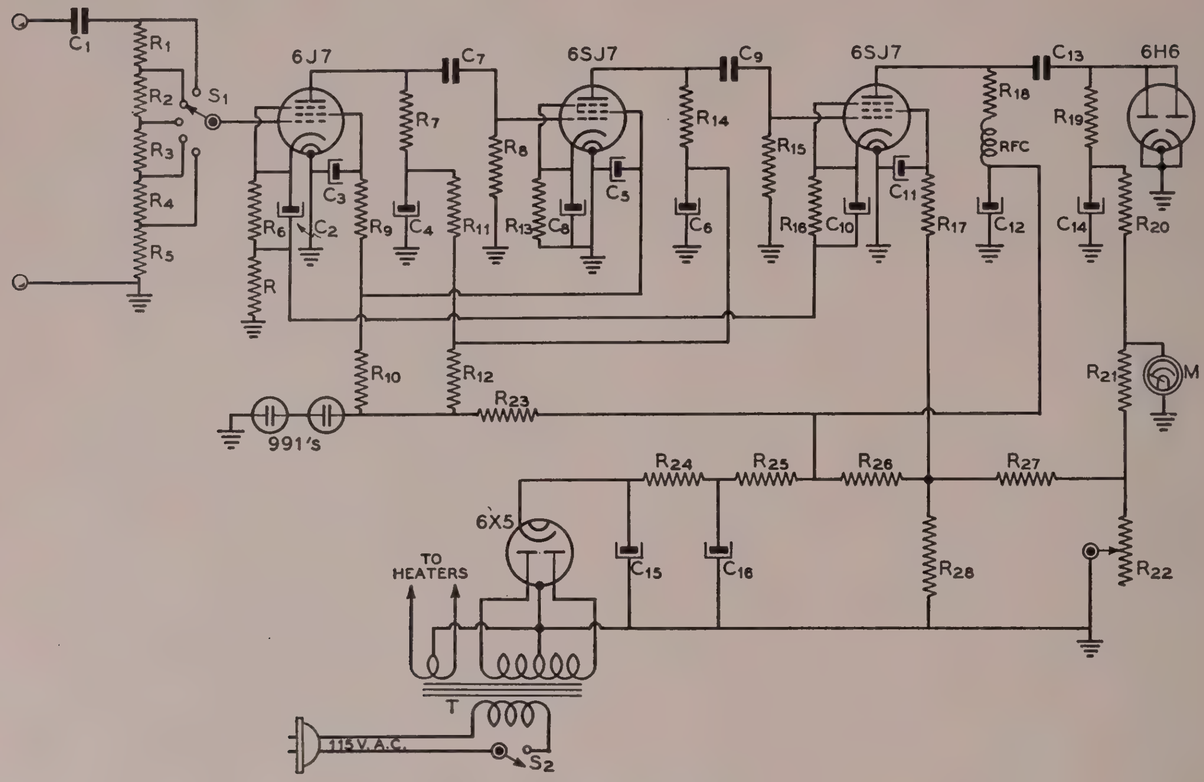



Figure 4, Wiring Diagram

$C_1$—.1 µfd. 600-volt tubular
$C_2$—25 µfd. 25-volt electrolytic
$C_3$—12 µfd. 450-volt electrolytic
$C_4$—8 µfd. 450-volt electrolytic
$C_5$, $C_6$—12 µfd. 450-volt electrolytic
$C_7$—.1 µfd. 600-volt tubular
$C_8$—25 µfd. 25-volt electrolytic
$C_9$—.1 µfd. 600-volt tubular
$C_{10}$—25 µfd. 25-volt electrolytic
$C_{11}$—12 µfd. 450-volt electrolytic
$C_{12}$—8 µfd. 450-volt electrolytic
$C_{13}$—.5 µfd. 600-volt tubular
$C_{14}$, $C_{15}$, $C_{16}$—8 µfd. 450-volt electrolytic
R—See text
$R_1$—450,000 ohms, wire-wound
$R_2$—45,000 ohms, wire-wound
$R_3$—4,500 ohms, wire-wound
$R_4$—450 ohms, wire-wound
$R_5$—50 ohms, wire-wound
$R_6$—2,000 ohms, wire-wound
$R_7$—50,000 ohms, wire wound
$R_8$—500,000-ohm, ½ watt
$R_9$—20,000 ohms, wire-wound
$R_{10}$—100,000-ohm, 1 watt
$R_{11}$, $R_{12}$—20,000-ohm, ½ watt
$R_{13}$—2,000-ohm, ½ watt
$R_{14}$—50,000-ohm, 1 watt
$R_{15}$—500,000-ohm, ½ watt
$R_{16}$—400-ohm, ½ watt
$R_{17}$, $R_{18}$, $R_{19}$—40,000-ohm, ½ Watt
$R_{20}$—1,000-ohm, ½ watt
$R_{21}$—100,000-ohm, 1 watt
$R_{22}$—25,000-ohm potentiometer
$R_{23}$—30,000-ohm, 1 watt
$R_{24}$, $R_{25}$—5,000-ohm, 2 watts
$R_{26}$—20,000-ohm, 1 watt
$R_{27}$—1 megohm, 1 watt
$R_{28}$—60,000-ohm, 1 watt
T—580 v., c. t., 50 ma.; 6.3 v., c. t., 2 a.; 5 v., 3 a.
$S_1$—5-position, single pole tap switch
$S_2$—S.p.s.t. toggle
RFC—80 mhy.
M—0-1 ma.

use 6SJ7 tubes because we want the grid leads where the 6SJ7 has them, on the bottom, again giving us short leads. The third stage feeds into a 6H6 diode rectifier, with rather a low load resistance and the milliammeter reads the rectified current as a function of the input voltage. The resistor network feeding into the meter from the power supply furnishes a small amount of current to buck out the zero voltage diode current which would flow due to the initial electron velocities. The 25,000-ohm wire-wound variable resistor provides a means of adjusting this bucking current, bringing the meter to zero with short-circuited voltmeter input. This resistor is mounted inside the unit, as it need be adjusted only upon changing the diode tube or to compensate for changes in this tube.

The cathode lead of the third stage is carried over and the cathode current passes through resistor R in common with the cathode current of the first amplifier stage. This is the feedback which furnishes the high stability of the amplifier and makes it retain its calibration. The feedback resistor is made from a piece of resistance wire—manganin, advance or nichrome—which may be taken from an old low-resistance rheostat. Five ohms should be sufficient to start with. Adjustment of this resistance calibrates the whole meter, and after adjustment the wire may be coiled around a pencil or piece of cardboard.

A word of caution might be in order here. Note that the negatives of the cathode by-pass condensers of both the first and third stages *do not* go to ground as is customary, but instead

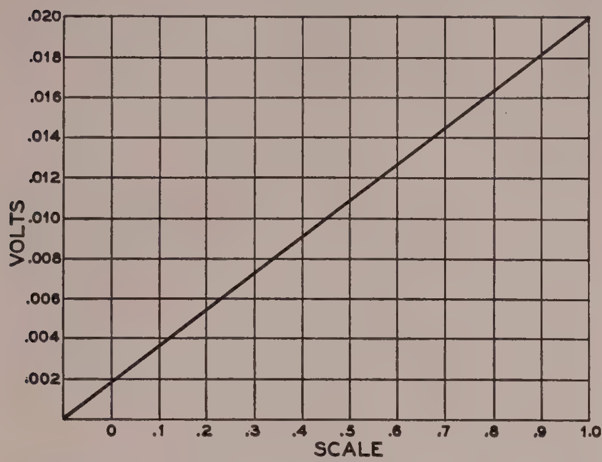



Figure 6. A typical calibration curve for the voltmeter. Since it is a straight line it is, of course, unnecessary to draw it.

are connected only across their respective cathode resistors. The feedback resistor R, mentioned above, is then left unbypassed.

The plate resistor for the various pentodes may appear to be unusually low, but this is one of the means used to obtain uniform gain over the desired audio frequency band. The r.f. choke in the third stage plate circuit is another means of flattening the gain at the higher frequencies, and the large by-bass condensers used at all points help bring up the low frequencies.

The power supply uses a 40- or 50-milliampere 300-volt transformer with a 6X5 or 5W4 rectifier and a resistance-capacity filter. The two RCA 991 neon bulbs in series stabilize the voltage and provide additional filtering action. Do not try to skimp on the various resistance-capacity filter circuits throughout the amplifier, or you may find difficulties with hum and frequency response arising.

The wiring is standard to anyone familiar with audio or speech amplifier work. Do not bunch leads carrying a.f. voltages, and keep all leads as short as possible. In checking the unit after completion, one difficulty arose which was traceable to wiring. The meter reading for an input 60-cycle voltage was different when the input voltage was reversed in phase. This made it look as though the input voltage was aided or bucked by hum pickup somewhere in the wiring. After investigation with a cathode-ray oscillograph, it was discovered that certain electrolytic condenser negative ground returns were not at ground potential, but were floating around with a small 60-cycle voltage on them. Four of these leads had been connected to the no. 1 terminal (shell) on a tube socket and 2 inches of wire run from that terminal to ground on the chassis. The electrolytic condenser returns were removed from the tube socket terminal and run individually to ground on the chassis. Then the ground wires became grounds, the trouble disappeared, and a 60-cycle input voltage read the same no matter what the polarity of the input.

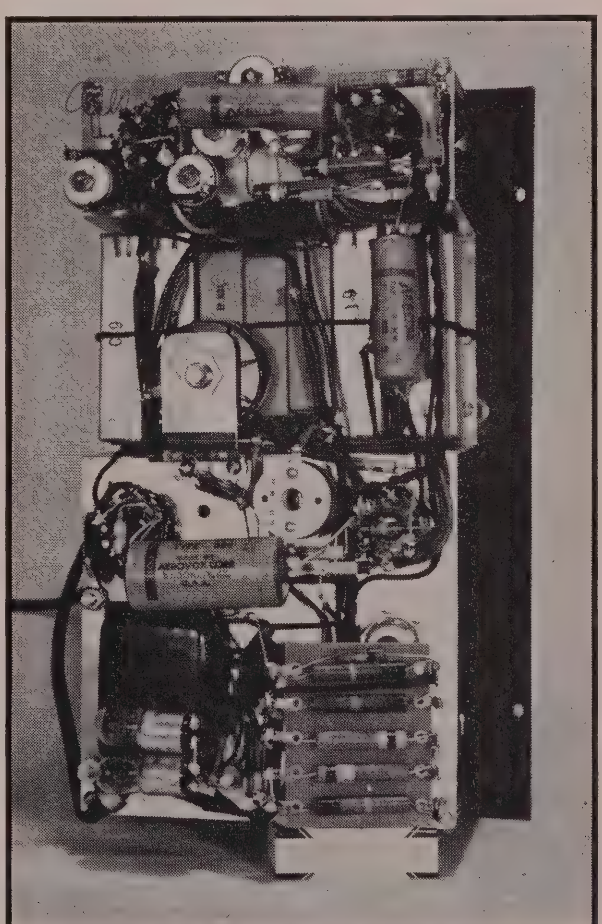
Moral: connect all ground returns of a stage direct to a ground point on the chassis common for that stage. This is standard r.f. practice, but is not so common in a.f. work.

With the wiring complete and the voltmeter operating to the extent that various a.c. input voltages produce various output meter readings, we are ready to calibrate. First, short circuit the input terminals and adjust the 25,000-ohm variable-bucking current resistor until the meter reads zero. This adjustment is not to be changed thereafter unless the 6H6 tube is changed.

## Calibration

The next step is to calibrate the attenuator or range resistors so that each range is an exact ten times multiple in voltage of the preceding range. This may best be done by careful measurement and selection of the attenuator resistors, or if exact values cannot be found, then

Figure 3. Rear of the unit. The input voltage divider resistors are grouped around the 6J7 socket. $R_{22}$ is mounted on a small bracket directly below these resistors.



parallel several resistors until combinations are found which give the correct values. Your voltmeter will be as accurate as your attenuator resistors. When this is completed, switching from one range to another and at the same time increasing or decreasing the input voltage by a factor of 10 should produce identical meter readings. You will then know that the voltage calibration which you obtain on any one range will be reproduced on any other range with the proper factors of 10 accounted for.

You are now ready for the final voltage adjustment. Apply a voltage of exactly 1 volt, 60 cycles, to the meter and measure this voltage with some other voltmeter of known accuracy. Now adjust the length of the feedback resistor R until a reading of 0.5 is obtained on the middle or no. 3 scale. This midscale reading is then 1 volt, corresponding to the reading of 1 volt set up on the other voltmeter (not necessarily a vacuum-tube type).

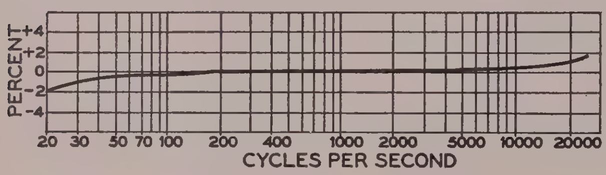



Figure 7. The frequency response of the unit. The flatness of the curve makes it possible to use the meter on all audio frequencies without correction factors.

If you now vary this input voltage you can check the linearity of your v.t. voltmeter calibration at various scale points. Two volts should read 1.0, 1.5 volts should read .75, 0.5 volt should read .25, etc. The other higher scales should be multiples of 10 of this scale, and can be checked by applying higher 60-cycle voltages. The lower ranges can be checked if two decade resistor boxes can be obtained and connected as in figure 5. With the voltages as indicated, each ohm in the box connected across the voltmeter will represent one millivolt, (.001 volt) so that the voltage being applied is directly readable. Note that in adjusting this voltage, if 1 ohm is added to box 1, then 1 ohm must be cut out of box 2, so that the sum of resistance in both boxes is always 2000 ohms.

If the attenuator resistors have been accurately chosen, however, there should be no difficulty with the various ranges checking out. Range 1 will be from 0 to .02 volt, range 2 from 0 to 0.2 volt, range 3 from 0 to 2 volts, range 4 from 0 to 20 volts, and range 5 from 0 to 200 volts, within a per cent or two. The scales should be linear so that multiplying factors of .02, 0.2, 2, 20, and 200 can be used on the 1 milliampere meter scale directly.

Figure 6 shows a typical calibration curve of the voltmeter if one needed to be drawn, and the frequency response characteristic plotted between 20 and 25,000 cycles is shown in figure 7. The flatness of response of this voltmeter at all audio frequencies can well be seen.

The constancy of reading or independence of line voltage fluctuations was checked, and it was found that for variations of line voltage between 100 and 120 volts, the voltmeter reading for a given constant voltage varied less than 1 per cent, sufficiently stable for all ordinary work. A number of tubes, in various states of use and disuse, were tried in the amplifier and no bad effects could be found. Such a test is a very beautiful demonstration of the efficiency of the feedback used in the amplifier.

The high sensitivity and wide voltage range of this meter, especially in the lower voltage

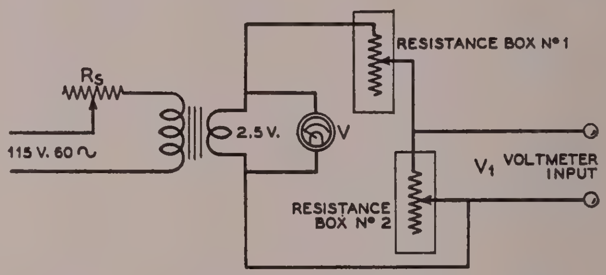
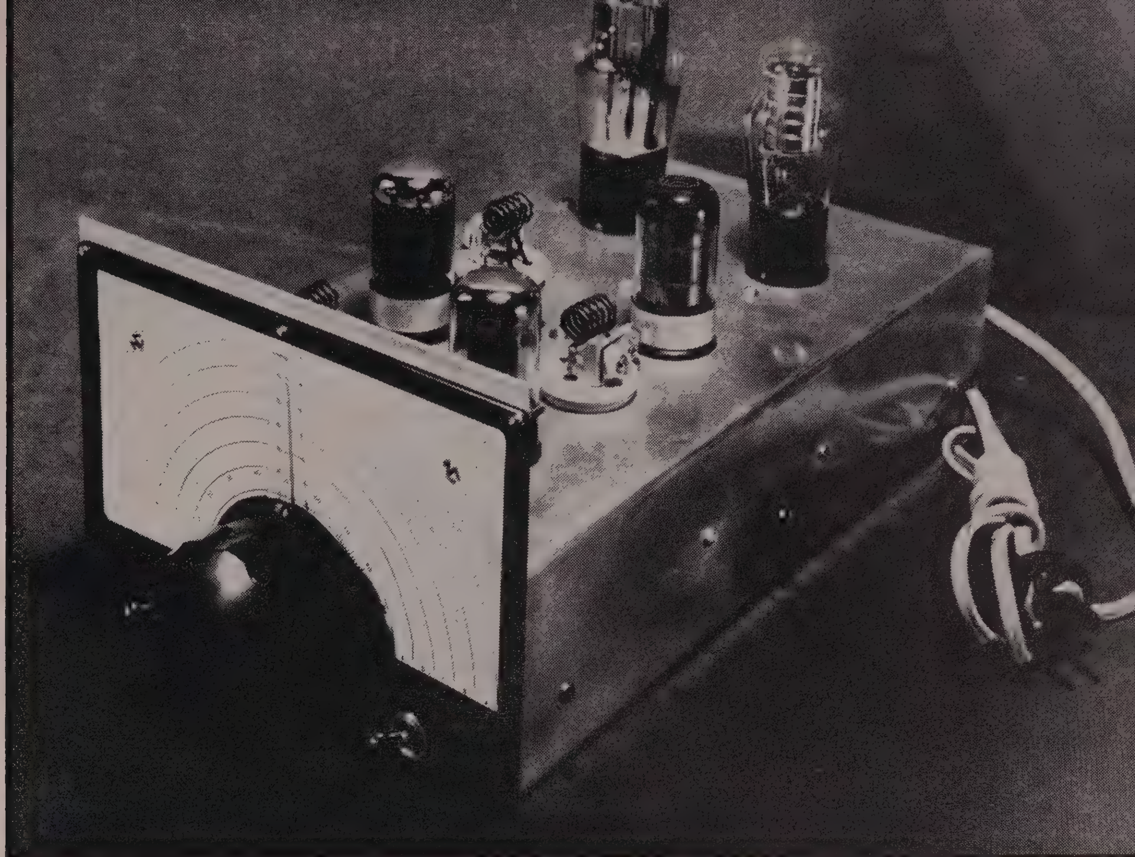



Figure 5. Circuit for calibrating the lower ranges. $R_s$ is adjusted for a reading of 2 volts on V. $V_1$ will then be equal to the resistance across the terminals of box 2 times .001. The sum of the resistances of the two boxes should be 2000 ohms at all times.

levels, permits its use in all manner of audio frequency checking. For instance, the signal in a speech amplifier may be checked circuit by circuit from the microphone output right up to the amplifier output, stage gains easily calculated, and any stage which is not doing its full duty easily found. By similar means, accurate measurements can be made on speech compressors, modulation limiters, and volume expanders. Many other types of circuits may be brought into the field of accurate measurement which operate at voltage levels much below the ranges of ordinary vacuum-tube voltmeters.



The a.c. and standby switches are mounted in holes drilled through the dial itself. From front to back—the oscillator coil and tube, the mixer tube and coil, the r.f. coil and tube, and the rectifier and regulator tubes.

# A 5- and 10-Meter CONVERTER

By EVERETT G. TAYLOR,* W8NAF

A converter and regular receiver combination is generally considered to be the ideal arrangement for 5- and 10-meter reception. This is partly due to the fact that few factory-built receivers have a 5-meter range, and the sensitivity on the 10-meter range is usually poor, while commercial communications-type receivers for this range are too expensive for most hams.

With a properly designed converter an ordinary b.c.l. receiver may be used for the intermediate frequency and audio channels to take care of 5- and 10-meter work. Such a converter must be stable and have high sensitivity, along with a good signal-to-noise ratio.

Consulting every issue that we have of RADIO, *QST*, and various other publications, produced no design that suited the writer's needs, so one was worked out using a 7V7 as an r.f. amplifier, a 7Q7 as the mixer, and a 7A4 for the oscillator. The rectifier is a 5Y3, and a VR-105 is used to stabilize the plate voltage on the oscillator.

### The Mixer

The heart of any receiver is the mixer. The use of a combination detector and h.f. oscillator tube is out—because of instability, which is greater at the higher frequencies. The choice of a 7Q7 lies in the fact that it has high gain and has better internal shielding between the signal and oscillator grids. To obtain this improved shielding, plates are used which are similar to the beam-forming plates in a 6L6. These plates are mounted in such a way that they split the electron beam and make the

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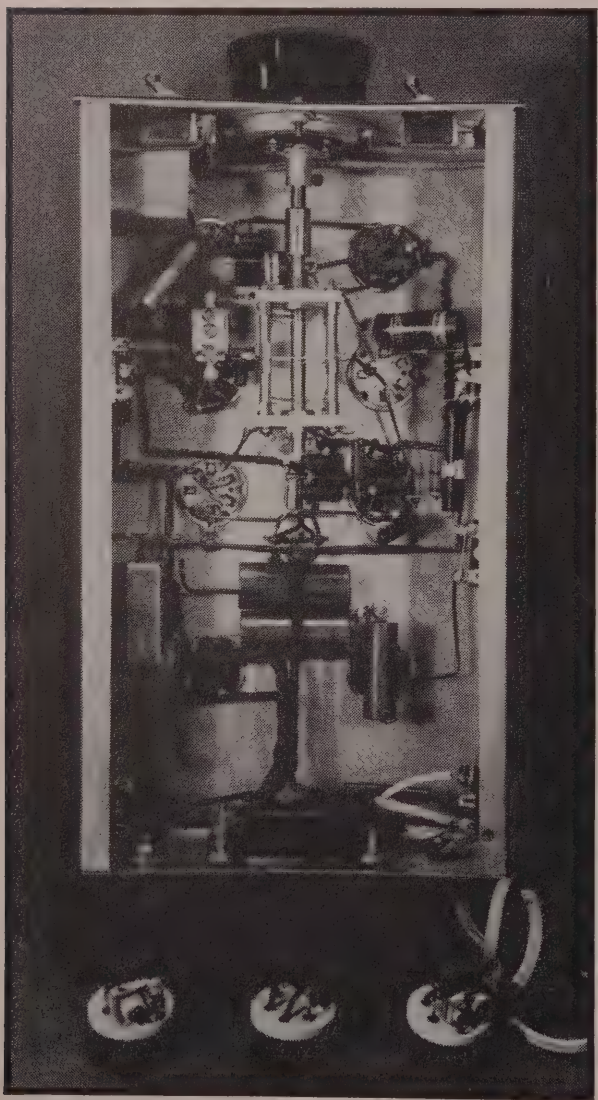
electrons travel in radial paths. The electrons that are turned back by the signal grid are prevented from returning to the no. 1 grid of the oscillator by the shielding plates.

This improves the stability by reducing the pulling to a minimum. Another advantage of the 7Q7 is that it does not load the oscillator heavily, thus giving better oscillator stability. A 1232 used as a mixer would probably give better gain and perhaps improved signal-to-noise ratio, but it has greater pulling tendencies due to the use of grid injection. The gain we might normally get by using the 1232 is made up by tuning the plate of the r.f. tube. We used grid-leak bias in the mixer to make it possible to ground the cathode directly, as this seemed to work better than a combination of grid-leak and cathode bias. $L_3$ is tuned to 1600 kc., and the transformer is made from one section of an i.f. transformer.

Under-chassis view of the converter. The wiring is well-anchored to prevent vibration. All a.c. leads are twisted. The home-made r.f. choke is visible in the corner near the i.f. transformer.



### The H.F. Oscillator

This section needs to be of good design mechanically as well as electrically, since a variation of the LC ratio means a change in the frequency of the signal fed to the intermediate stage. One of the new XXL tubes may be used in place of the 7A4, and will give a slightly better LC ratio, as its internal capacity is less than that of the 7A4.

For stability we used a plate-tuned coil, with the tickler in the grid circuit. This circuit, along with the voltage regulated supply gives very good stability even on 5 meters. One thing that helps the pleasing stability of the signals is the fact that the cathode is at ground potential and not above ground, as in the case of an e.c. oscillator. With a.c. on the filament of a tube designed for d.c., hum is very apt to creep into the cathode circuit, causing modulation of a 60-cycle variety which is in turn detected in the mixer stage.

### The R.F. Stage

It is generally conceded that an r.f. stage must be tuned in its output circuit to obtain the greatest gain. This may sometimes lead to trouble, but by using proper by-pass condensers and de-coupling resistors the chances of oscillation are reduced to a minimum. A combination of grid-leak and cathode bias results in greater sensitivity than would otherwise be had by using one or the other alone. A 1-megohm resistor is used as a grid leak, with a 75-$\mu\mu$fd. grid condenser; the cathode resistor has a value of 2,000 ohms, and is bypassed with a .01-$\mu$fd. condenser. The antenna coil is inter-wound with the grid coil on the ground end of the latter.

### General Mechanical Layout

The converter is built on a 12x7x3-inch cadmium-plated no. 18 gauge chassis. At the left side of the rear drop is the antenna input. The power transformer is mounted in the center of the drop to conserve space on top and to reduce vibration, which would affect the stability of the oscillator. To the right of the transformer are holes for passing the a.c. cord and the output lead. This lead is shielded and grounded to the converter chassis at one end and to the receiver chassis at the other.

At the rear of the chassis are the 5Y3 and the VR-105. The r.f. tube and grid coil are next going forward, then the mixer tube and coil, with the oscillator tube and coil at the front directly behind the dial.

The dial is backed up by a piece of electralloy to reinforce it. This dial is one of the

most efficient for the price that we have been able to find. The standby switch is at the left and the a.c. switch is on the right. Isolantite sockets are used for the coils and mica-filled sockets for the loktal tubes. The coils are mounted on plug-in bases and are air-wound. 3-50$\mu\mu$fd. trimmer condensers are soldered directly across the coils for spotting the bands. A 3-gang 10-$\mu\mu$fd. per section condenser is used for main tuning. All resistors except one are of the ceramic molded type. A .05-$\mu$fd. condenser from the anode of the VR-105 to ground improves the bypassing of the oscillator positive return.

The condensers in the grid circuits are all of the low-loss variety. The r.f. choke in the oscillator plate circuit is made by winding a 1-watt metallized resistor full of no. 26 wire. The resistor should have a value of 1 megohm or more. $R_9$ drops the output voltage from the filter to a value that the VR-105 can handle. The i.f. transformer is mounted near the front, directly behind the standby switch. It is tuned from the side of the chassis, and once set requires no further adjustment.

R.f. wiring is done with no. 12 enamelled wire, and no. 18 cellulose pushback wire is used for the remainder of the wiring. Plenty of terminal strips are used to anchor long wires and reduce opportunities for vibration. Cable clamps are used to hold the wires running from back to front along the sides of the chassis. All the heater and other a.c. leads are twisted.

[*Continued on Page 79*]

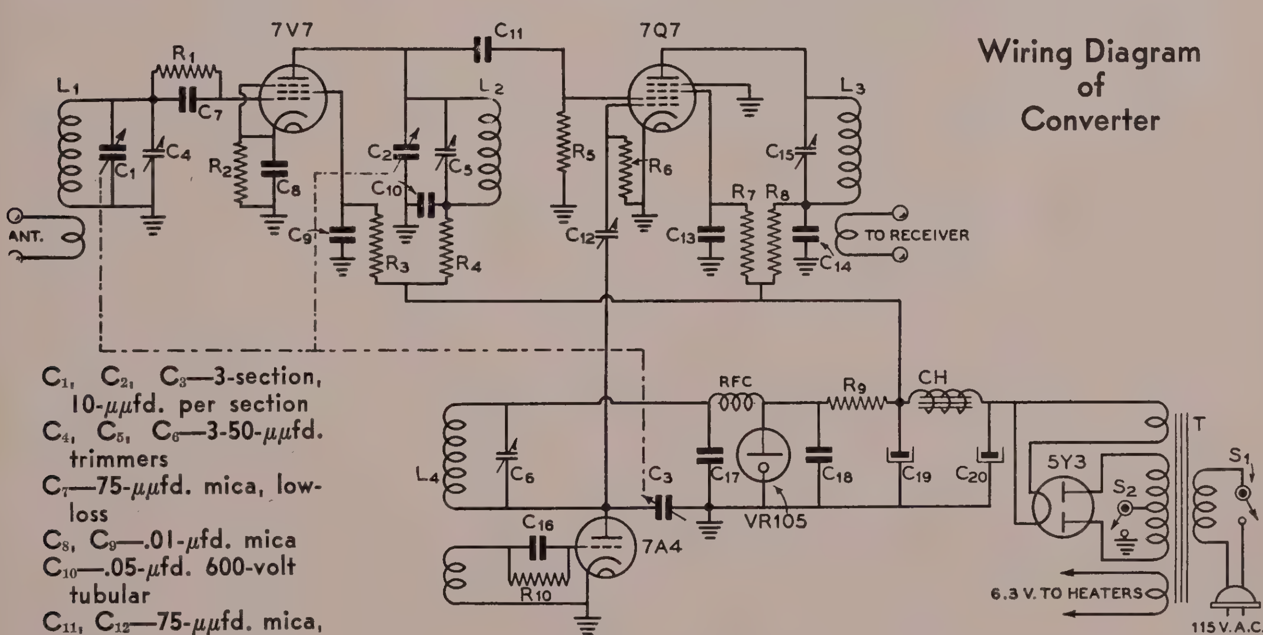
### Coil Data

| | Turns for 56 Mc. | Turns for 28 Mc. |
|---|---|---|
| Antenna | 3 | 3 |
| $L_1$ | 5 | 9 |
| $L_2$ | 6 | 9 |
| $L_4$ | 6 | 8 |
| Tickler | 2 | 2 |

56-Mc. coils are space-wound with no. 18 wire, ¼″ in diam.

28-Mc. coils are close-wound with no. 12 wire, ¾″ in diam.

The output winding of $L_3$ is wound with 10 turns of hook-up wire around the bottom of the 1600-kc. coil.




Wiring Diagram of Converter

$C_1$, $C_2$, $C_3$—3-section, 10-$\mu\mu$fd. per section
$C_4$, $C_5$, $C_6$—3-50-$\mu\mu$fd. trimmers
$C_7$—75-$\mu\mu$fd. mica, low-loss
$C_8$, $C_9$—.01-$\mu$fd. mica
$C_{10}$—.05-$\mu$fd. 600-volt tubular
$C_{11}$, $C_{12}$—75-$\mu\mu$fd. mica, low-loss
$C_{13}$, $C_{14}$—.05-$\mu$fd. 600-volt tubular
$C_{15}$—Trimmer in i.f. transformer
$C_{16}$—75-$\mu\mu$fd. mica, low-loss
$C_{17}$, $C_{18}$—.05-$\mu$fd. 600-volt tubular
$C_{19}$, $C_{20}$—8-$\mu$fd. 450-volt electrolytic
RFC—See text

$R_1$—1 megohm, ½ watt
$R_2$—2,000 ohms, 1 watt
$R_3$—75,000 ohms, ½ watt
$R_4$—2,000 ohms, 1 watt
$R_5$—1 megohm, ½ watt
$R_6$—20,000 ohms, ½ watt
$R_7$—50,000 ohms, ½ watt
$R_8$—2,000 ohms, 1 watt

$R_9$—5,000 ohms, 10 watts
$R_{10}$—50,000 ohms, ½ watt
T—700 v., c.t., 70 ma.; 6.3 v., c.t., 2.5 a.; 5 v., 3 a.
$S_1$, $S_2$—S.p.s.t. toggle
CH—30 hy., 75 ma.
$L_1$, $L_2$, $L_3$, $L_4$—See coil table

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## The Feed System

The centers of the four driven elements are directly connected together by a phasing section of no. 4 wire spaced 2 inches. This section of 350-ohm line is *not* crossed over in interconnecting the ends of the four driven elements because the array is fed at the *center* of the phasing section.

Then, the best way to determine the proper value of characteristic for the Q bars which connect the center of this 8 foot 5 inch phasing section to the transmission line to the transmitter is to connect the transmission line directly to the center of the phasing section, excite the array with the transmitter, and measure the standing wave ratio on the line to the transmitter by means of a thermogalvanometer. The standing wave ratio divided into the characteristic impedance of the line to the transmitter will give the value of impedance to be matched at the center of the phasing section (provided, of course, everything is in resonance). Then the characteristic impedance of the quarter-wave Q bar between the center of the phasing section and the line to the transmitter will be the geometric mean between the line impedance and the value of feed impedance just determined.

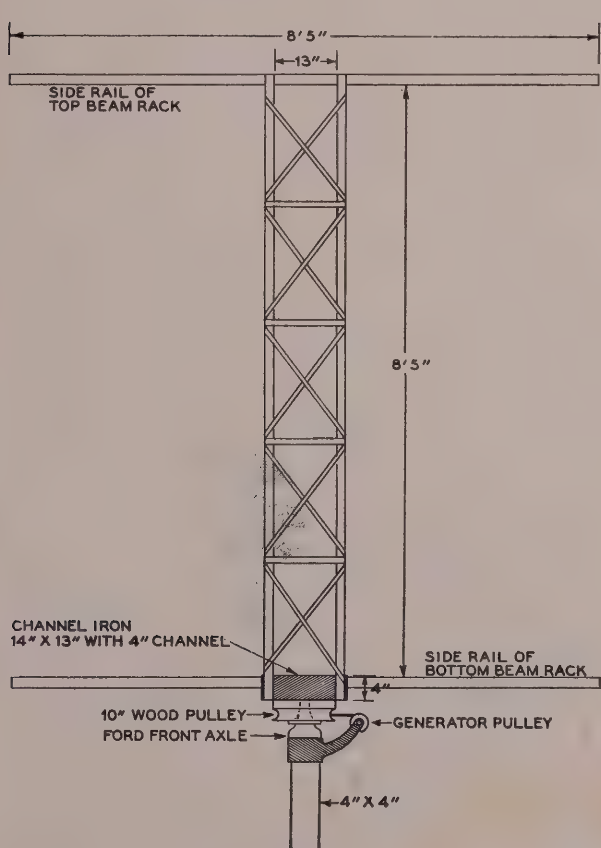



Figure 1. Side detail of the beam rack and rotating head.

Figure 2. Top view of the upper and lower racks of the beam array.

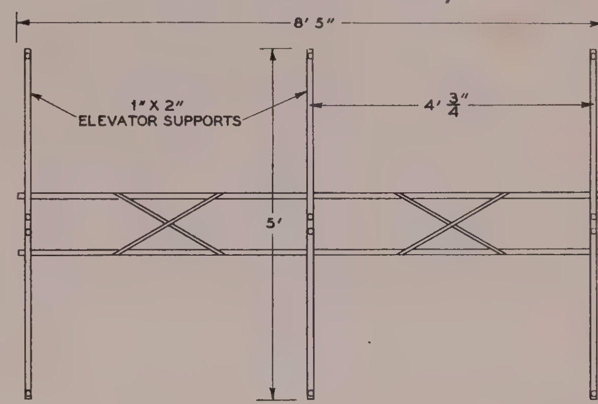
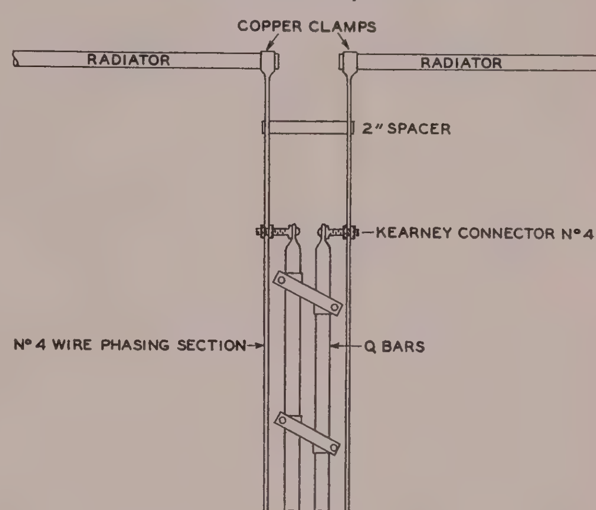


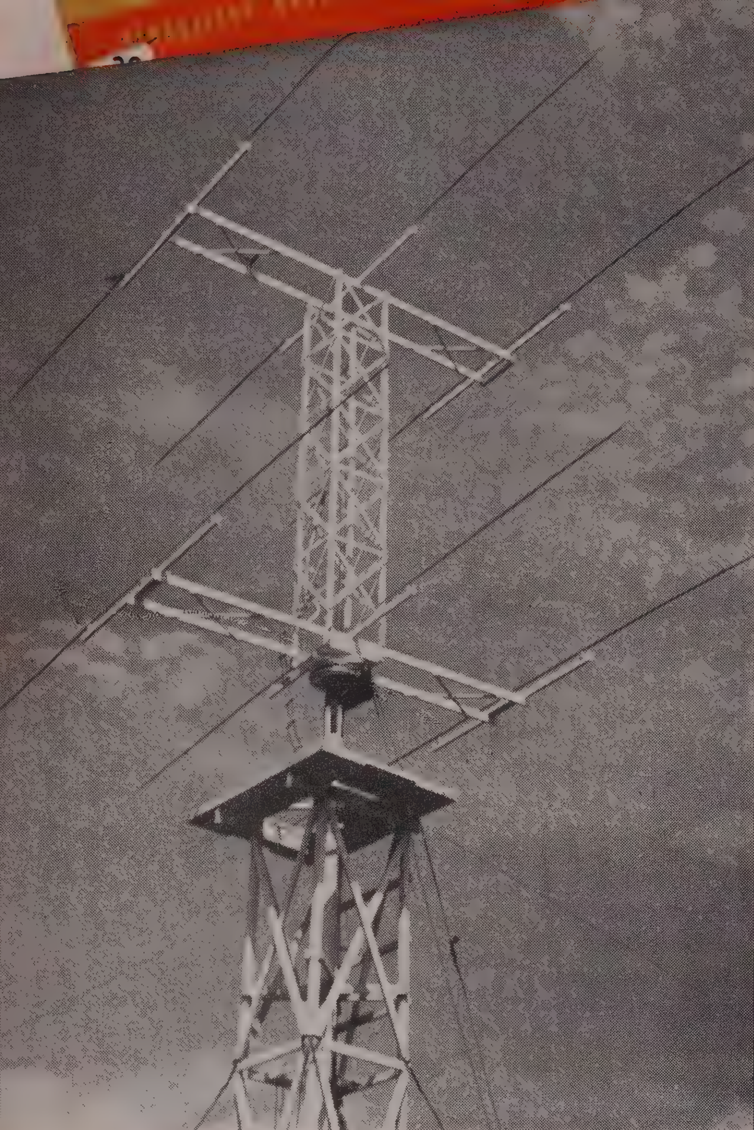

Figure 3. Detail drawing of the phasing section and the Q bars.




In the particular case of the array described, the standing wave ratio worked out to be 12-to-1, which meant (since a 500-ohm line was being used) that the impedance to be matched was about 40 ohms. The geometric mean between 500 and 40 is 142. Hence the quarter-wave section should have a characteristic impedance of 142 ohms. This value of impedance was obtained by means of a Q section composed of standard ½-inch tubing spaced 0.8-inch center to center and 4 feet ¼ inch long.

In any case, after the array has been installed it is well to examine the line for standing waves and make adjustments to the Q bar spacing in very small steps until the lowest possible value is obtained. It is well to remember that the line can only be flat for one frequency with a given Q bar adjustment. But it was found that this array works beautifully over a fairly wide range of frequencies, nothwithstanding the fact that small standing waves are present on the line when other frequencies are used.

[*Continued on Page 87*]



# A 12-Element ROTARY for 56 Mc.

By

W. A. COPELAND,* W9YKX

A great many three-element beams of the quarter-wave-spaced variety have been in use for five-meter work. In most instances these arrays have given very fine performance.

While casting about for something a little more elaborate, the gain calculated for a number of such units stacked and broadsided appeared to be well worth while. For instance, the familiar H array with reflectors and directors spaced 1/4 wave should have a gain of about 3 db for the broadsiding and another 3 db for the stacking, providing it is equally effective in both planes. This alone would show up on a distant receiver as an increase of half an R over the three-element beam. However, these theoretical gains are far exceeded in apparent gain, due to the great increase in low-angle radiation as a result of the stacking. In some instances 20 db or more has been realized on long extended ground wave work. This of course means that the signal from such an array may rise up out of the noise level and be easily read when the smaller antenna is producing signals which are down in the noise.

*Woodbine, Iowa.

With the foregoing in mind, let us consider the construction and feeding of such an antenna. All that is required from the constructional standpoint is to build two ten-meter beams of the close-spaced variety, cut all the elements in two, and stack the assemblies one above the other about 8 feet apart. Then connect the radiators together with a phasing line and feed them in the best possible manner, preferably at the center of the system.

### Dimensions

The array designed and built by the writer was cut to work at the center of the five-meter band and the element lengths are as follows: radiators, 8 feet 1½ inches; reflectors, 8 feet 5 inches; and directors 7 feet 7 inches. The spacing between radiators and reflectors and between radiators and directors is 4 feet ¾ inch. The phasing section is no. 4 wire spaced 2 inches and is 8 feet 5 inches long. It is believed by the writer that these dimensions may be followed accurately to give excellent results, provided the whole structure is placed well up in the clear.

## The Feed System

The centers of the four driven elements are directly connected together by a phasing section of no. 4 wire spaced 2 inches. This section of 350-ohm line is *not* crossed over in interconnecting the ends of the four driven elements because the array is fed at the *center* of the phasing section.

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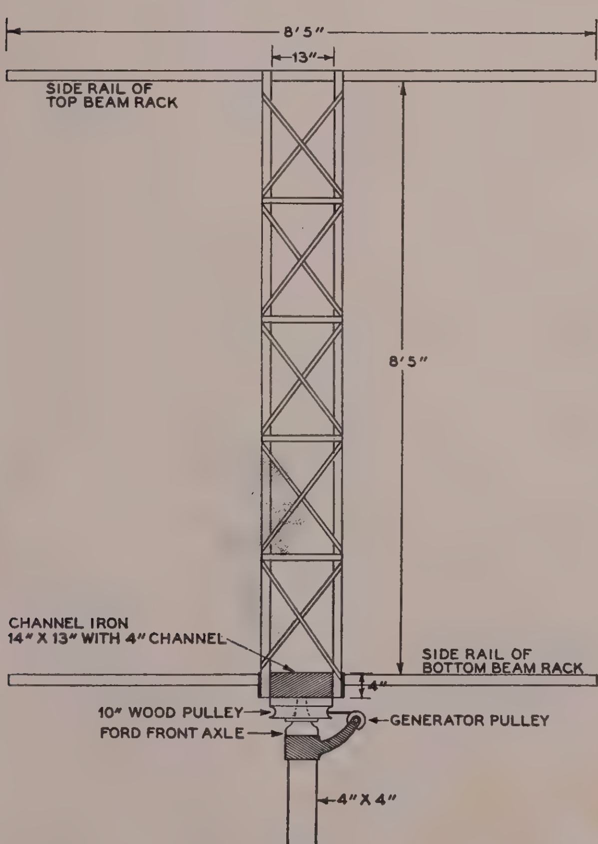


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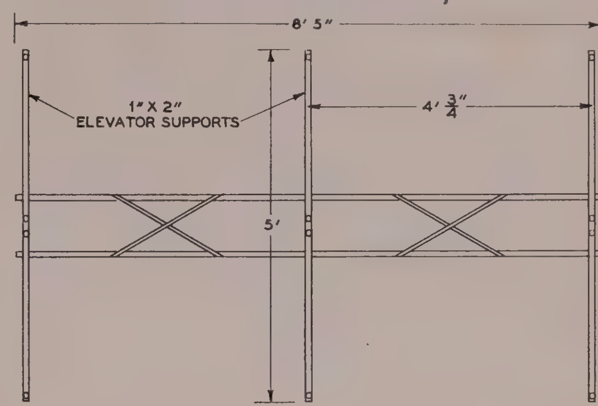


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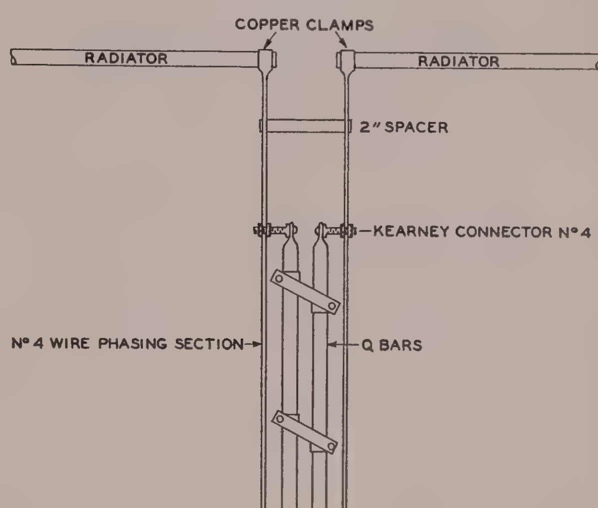


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[*Continued on Page 87*]

# An Inexpensive Electronic Bug

By D. L. CLARK,* W1MJU

Some months ago I felt a desire for an electronic bug that would make dots and dashes automatically and thus make it easier to send good code at a higher speed than that attainable with a hand key. None of the bugs described in the literature at hand suited me so a new one was developed.

After a little preliminary experimenting the following list of features to be included in the design was set down:

1. It must make a steady string of dots or dashes as long as the key is held against the appropriate contact.
2. All dots or dashes in a string must be of the same length, i.e., it must not go daahh, dah, dah, dah, dah.
3. The speed must be readily adjustable by turning a single control.
4. It must be simple and cheap to build.
5. It should be capable of keying the ordinary crystal oscillator or low power buffer.
6. It should take its power directly from the 115-volt line or one of the power supplies already in use in the transmitter.
7. It must provide a good keying characteristic with no click or thump.

The design finally worked out satisfies all these requirements except the one specifying a single control for varying speed.

The first circuit tried was an oscillating neon lamp controlling a relay. But this was immediately discarded because the key was not at ground potential (offering a shock hazard) and a fairly sensitive relay was required. The next circuit tried was a multivibrator controlling a keyer tube but this was ruled out because it required an extra power supply, the key was not grounded, and it would start a string of dots or dashes with a space, which of course would make it impossible to send code with it. The circuit finally used consists of a keyer tube as one tube in a multivibrator circuit with another smaller tube as the other multivibrator tube.

As most amateurs know, a multivibrator is a type of oscillator in which the frequency is determined by resistors and condensers. This offers a very cheap and easy way to generate a frequency low enough to be used for dots or dashes. Also, the frequency can be varied easily by means of a variable resistor. The fundamental circuit of the multivibrator is shown in figure 1, but several changes were necessary to make it usable as a bug.

For one thing, the voltage drop across the triode used as the keyer tube was objectionable. This was overcome by using a pentode as the keyer tube. The characteristics of a pentode are ideally suited for this use, as the screen voltage neutralizes most of the space charge and makes the voltage drop from plate to cathode very low when there is no negative bias on the control grid. In this bug, the voltage drop using a 6F6 for the keyer tube was less than 3 volts at 30 milliamperes with 130 volts on the screen. About 50 milliamperes can be passed by a single 6F6 without increasing this

Figure 3. Front view of the unit.


*Waitsfield, Vermont.

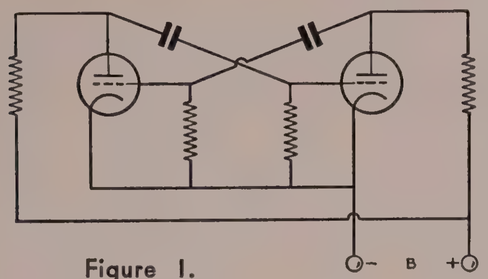


Figure 1.
Fundamental multivibrator circuit.

voltage drop appreciably. This makes it possible to key the ordinary 6L6 or 6F6 crystal oscillator.

The cathode return of the 6F6 keyer tube was broken to provide a keying control for the bug. This made it unnecessary to provide a bias supply to cut off plate current through the 6F6 when nothing was being sent. Also, it makes the bug start a character with a dot or dash instead of a space, which is, of course, necessary if code is to be sent with it.

When the simple multivibrator circuit was keyed in this manner it had a tendency to lengthen the first dot or dash in a string, making a daah, dit, dit, dit effect. This was due to a negative bias building up on the grids of the tubes, with the frequency increasing with the bias. A 1-meghom resistor in series with each grid effectively overcame this by making it impossible to swing the grids positive appreciably ($R_1$, $R_2$, $R_3$, $R_4$, in figure 2).

Up to this point a speaker had been used in series with the plate of the keyer tube to judge the speed and characteristics of the oscillations produced by the bug. However, when the speaker was replaced by a crystal oscillator the oscillations became very unstable and it was utterly impossible to send readable code. The cause of this instability was due to the characteristics of the keyed stage which made a variable load on the keyer tube and consequently made the frequency variable.

The load resistance as it appears to the keyer tube varies from a few thousand ohms to nearly infinity as the cathode potential of the crystal oscillator rises to a point approaching cut-off on each dot or dash. The insulation resistance then plays an important part in determining the load resistance and, since this resistance is rather indefinite, instability results. The remedy for this was to connect the cathode to a voltage divider which would cause the tube to be biased beyond cut-off and at the same time present a relatively low resistance to the keyer tube so that insulation leakage would have little effect. The load presented to the keyer tube is still variable, but it varies the same amount on each dot or dash so that all dots or dashes in a series are the same length.

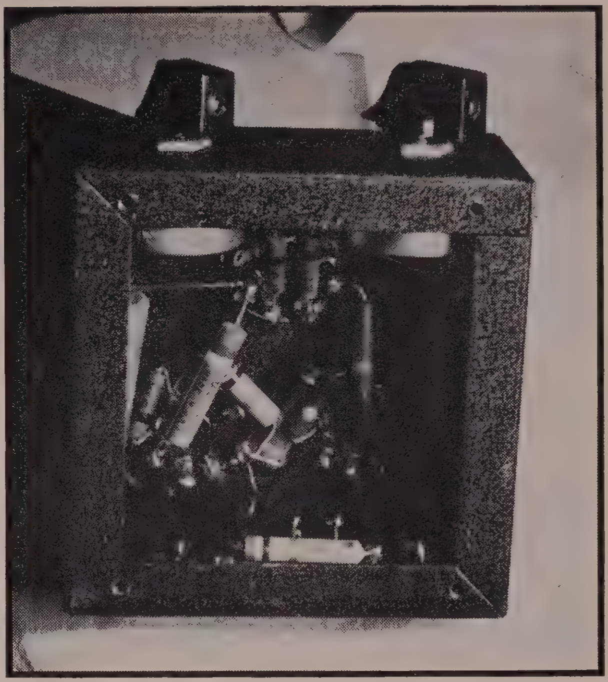

Figure 4.
Underchassis view of the electronic bug.

The oscillator voltage divider consists of $R_{11}$ and $R_{12}$ (figure 2) the values of which are not critical as long as the keyed stage is biased beyond cut-off. Figure 3 shows how the keyed stage is biased beyond cut-off by the voltage divider. Suppose that 30 volts of negative bias is required to cut off plate current of tube V at the plate voltage used. $R_{11}$ and $R_{12}$ would then be proportioned to provide 30 volts or more from their junction to ground (B−). With the key open, the cathode will assume the potential at the junction of $R_{11}$ and $R_{12}$, and tube V will be biased to cut-off or beyond.

In the fundamental multivibrator circuit (figure 1) the two condensers are usually equal in capacity, but in the practical circuit it was necessary to use unequal capacities to make the circuit produce dashes. The values used (0.1 and 0.25 $\mu$fd.) make dashes well up to about 35 words per minute, but beyond this speed the dashes tend to become too short in relation to the spaces. Equal capacities were used in the dot section of the keyer and good dots are made down to about 15 w.p.m. At lower speeds the dots tend to become lengthened to dashes, but fairly good code can be sent at speeds as low as 10 words per minute.

The keying characteristic produced by this bug is very good. There is no click, thump, or tail when the bug and keyed stage are properly adjusted. (Increasing the value of $R_{11}$ will eliminate any tails.) The keying is sharp and clean with no trace of "softness." Chirps may show up if this bug is used to key a v.f.o. but no trouble should be experienced with a crys-

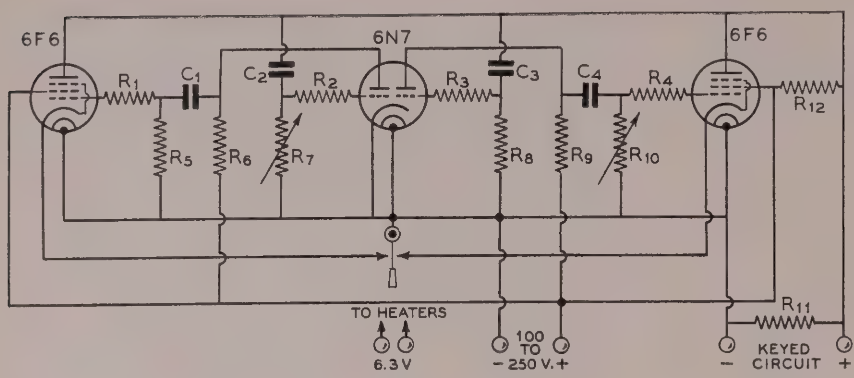


Figure 2.
Practical circuit of the electronic bug.

$C_1$, $C_2$, $C_3$—0.1-$\mu$fd. 400-volt tubular
$C_4$—0.25-$\mu$fd. 400-volt tubular
$R_1$, $R_2$, $R_3$, $R_4$—1.0 megohm, ½ watt
$R_5$—500,000 ohms, ½ watt
$R_6$—250,000 ohms, ½ watt
$R_7$, $R_8$—1.0-megohm potentiometer
$R_9$—50,000 ohms, 1 watt
$R_{10}$—250,000 ohms, ½ watt
$R_{11}$, $R_{12}$—50,000 ohms, 1 watt

tal oscillator or a v.f.o. which is designed to be keyed. Keying may be somewhat erratic with a crystal oscillator unless it is properly tuned for good keying.

The bug illustrated in the photographs was built on a 4 x 4 x 2-inch chassis. No dimensions are given, since the parts may be placed in any convenient arrangement. Length of leads is unimportant. The only precautions it is necessary to observe are that the grid leads should not be run through strong r.f. or a.c. fields. If r.f. gets into the bug, a by-pass condenser from each grid to its respective cathode will take care of it (.0001 to .001 will be satisfactory). The works may be tucked away on any convenient chassis corner if desired and leads run to the speed controls located in a convenient position on the operating table.

The key used to control the bug may be a converted mechanical bug or a "side-swiper" made from contents of the junk-box. One side-swiper used by a local ham was made from a knife blade for an arm, wood screws for contacts, and a large rubber eraser for the handle.

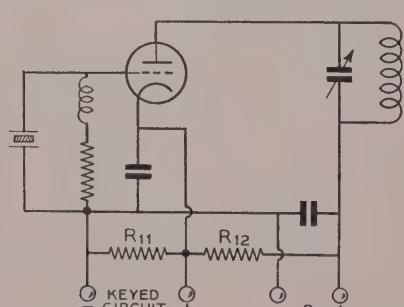


Figure 5. Method of connecting the bug to the keyed stage. The resistors $R_{11}$ and $R_{12}$ are also included in the main circuit diagram, but may actually be placed either in the bug unit or at the keyed stage.

However, this arrangement was not all that could be desired, as it did not have a dead center position and would flop against the contacts when the operator did not have a firm grip on it. It is suggested that an arrangement be worked out similar to a mechanical bug where the arm has a definite center position.

In case it is desired to key more than 50 milliamperes or so additional, 6F6's can be paralleled with those in the bug, adding one pair of 6F6's for each 50 milliamperes. Other tubes such as 6K6G, 6L6, 41, 42, etc., can also be used in the bug without change.

The power supply used with the bug should deliver from 100 to 250 volts at about 30 milliamperes. The regulation must be fairly good if the dashes are to be made properly. The voltage may be obtained from a tap on a bleeder if the bleeder current is heavy, but it cannot be obtained through a dropping resistor. The power supply need not be particularly well filtered. Voltages over 250 should not be used, because the screen dissipation of the 6F6's would be excessive.

Learning to use the bug is the most difficult part of the job (I haven't mastered the thing myself as yet). When first starting to use it, the speed should be set as low as possible and care should be taken that the dots and dashes are of the right relative speed. (The speed is right when there are twice as many dots in a given period of time as there are dashes. That is, it should take the same length of time to send, say, 25 dashes or 50 dots.) When you can send fairly well very slowly, gradually increase your speed until you reach your copying speed but don't try to go beyond. With a little practice it should become easy to change speed quickly as circumstances demand. It might appear to be a nuisance to have to turn

[Continued on Page 77]

# V.F.O. DESIGN CONSIDERATIONS

By W. W. SMITH,* W6BCX

Regardless of the particular circuit and type of construction employed, there are a number of important factors that should be given due consideration when designing a variable frequency oscillator for exciter service.

In the last year or two there have appeared many dozens of construction articles on v.f.o. exciters. Some of these units were good, some fair, and some pretty bad. But before going further, let's decide just what we mean by a "good" v.f.o. Certainly a v.f.o. that is to be used only for 160-meter phone need not be as elaborate an affair as one to be used for 28 Mc. c.w. The requirements on the unit are not as stringent. However, the simpler v.f.o., though not having sufficient stability for 28 Mc. c.w., may be considered as a "good" job if its limitations are appreciated and it is used only for the purpose for which it was designed.

It is for this reason—the various degrees of stringency as to requirements—that a v.f.o. of certain design or manufacture may have two reputations: one for being positively the best v.f.o. in existence, the other for generating a signal with an onerous odor.

One v.f.o. unit which is widely popular among 'phone men does not enjoy the same compliment from the c.w. fraternity, especially with regard to those c.w. men using high power on the higher-frequency bands. The reason is obvious. A small amount of drift or instability can be tolerated for 'phone operation, but when a fellow is trying to coax a 14 Mc. or 28 Mc. signal through a crystal filter the signal must be well nigh perfect.

It is the purpose of this article to help those building a v.f.o. to construct one which will deliver a signal which is "well nigh perfect," *regardless of the basic circuit employed.* Then, one is ready for anything: 'phone, c.w., low-frequency operation, high-frequency operation, low power, or high power.

### Oscillator Frequency

As the heart of any v.f.o. is the oscillator, the oscillator deserves first consideration. The oscillator always should operate on a frequency lower than the operating frequency, and preferably on the lowest possible frequency. The first requirement is dictated by the fact that it is virtually impossible to isolate the oscillator properly when the final amplifier is operating on the same frequency with considerable power. While it *can* be done by elaborate shielding and several properly designed buffer stages, it is much simpler to design the oscillator so that the frequency always is doubled at least once.

The advisability of using the lowest practicable operating frequency results from the fact that, contrary to popular belief, the maximum obtainable stability is *not* the same for all frequencies when figured on a percentage basis. Until one gets below about 500 kc., it is possible to get not only greater *absolute* (kc.) stability, but greater *relative* (percentage) stability at a lower frequency. The reasons for this have been explained in detail by Walter van B. Roberts (see bibliography).

This indicates the desirability of putting the oscillator in the broadcast band, especially when transmitting in the 160-meter band. This calls for certain precautions to avoid the generation of interference to nearby broadcast receivers. The oscillator should be run at a very low power level (comparable to that of the

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*RADIO.

oscillator in a superhet receiver) and should be especially well shielded. Power leads to the oscillator should be carefully bypassed to the chassis where they enter the v.f.o. cabinet.

### Oscillator Tube

The oscillator tube should have high transconductance, low interelectrode capacity, and be as non-microphonic as possible. The 6J5 or 6K8 is recommended as a triode oscillator, the 6F6-G as a pentode oscillator; but other tubes may be used with success if they meet the foregoing specifications. Regardless of the type tube used, it is desirable to try several in order to find one with the lowest possible microphonics; tubes are not uniform in this regard, and one tube of a certain type may be found to be much less microphonic than another of the same type. The term "microphonic tube" includes not only a tube which has a bad frequency wobbulation coefficient of vibration, but also a tube which has internal connections which are not stable with temperature. A tube falling in the latter classification will cause sudden jumps in frequency or "pings" as the tube warms up, even though the continuous drift may not be serious. The best way to check for microphonics is to beat the v.f.o. against a crystal while listening to the 10-meter harmonic of the crystal.

The plate input to the oscillator should be only a small fraction of the heater power, preferably not over one-third, unless provision is made to keep the plate dissipation constant on standby. The heater dissipation taken alone will cause the tube to reach a substantially constant temperature within a very few minutes, but if the plate input is high in proportion to the heater power, there will be a considerable increase in the temperature of the tube each time plate voltage is applied. Running the oscillator at low input is much simpler than providing a means of maintaining the plate dissipation during standby periods.

It is preferable, though not absolutely necessary, to use a circuit which permits grounding of the cathode of the oscillator tube. Greater care must be taken with a "hot cathode" oscillator in order to avoid feedback and hum.

If the oscillator is of the electron-coupled type, which calls for a "hot cathode," one side of the heater should be connected directly to the cathode. This will necessitate an interwound filament winding on the oscillator tank coil to supply voltage to the other leg of the heater. If the cathode is run "hot" with the heater at ground r.f. potential, as sometimes is done, the heater-cathode capacity will appear across part of the oscillator tank coil. The frequency of such an oscillator is seriously affected by line voltage changes, which cause a change in heater temperature with a consequent change in heater-cathode capacity. Running the heater at cathode r.f. potential avoids this difficulty.

### The Oscillator Tank

While an oscillator tank with a Q of several thousand would be very fine indeed, such is not possible of attainment except with a coaxial line, and the latter is impractical for low-frequency operation because of physical limitations. Fortunately, very stable operation can be obtained with a tank of quite modest Q if the oscillator is protected from voltage changes and is sufficiently isolated by means of buffer stages. This means that one need not go to great lengths to obtain the highest possible Q. The tank Q will be determined primarily by the Q of the coil, as the Q of a good condenser is many times that of the best coil. And while a 1000-2000 kc. coil with a Q of 150 is not especially hard to make, a coil with a Q of 250 is something else again. As there will be little difference in operation with such an order of difference in Q, the reader can better concern himself with such things as mechanical rigidity and temperature effects, and be content with moderate Q.

Rather than rely too much on temperature compensating capacitors, it is preferable to reduce the oscillator drift to the lowest possible value—if possible, to such a value that no compensation is required. The more compensation employed, the greater will be the difficulty in getting the compensation to "track" under all conditions of operation.

The temperature coefficient of the tank coil can be reduced to a very low value by utilizing a ceramic form and maintaining the space-wound wire under sufficient tension that the linear expansion of the wire is limited to that of the ceramic form. The expansion of ceramic is only from ⅓ to 1/6 that of copper (depending upon the particular type ceramic). Number 20 enamelled or bare copper wire may be stretched almost to the breaking point, wound on a ceramic form, all tapped connections soldered, and then pulled very tight while both form and wire are warmed to the highest temperature that will permit handling.

If the wire is firmly anchored before the coil is permitted to cool, the result will be a coil with a temperature coefficient that compares quite favorably with a coil wound with silver-plated invar wire on a ceramic form. However, to keep distributed capacity from being a factor, the turns should be spaced at

least their own diameter. If this is done, the *length* of the wire will be the prime frequency determining factor.

If the operating room is kept at a reasonably uniform temperature, there is no need to house such a coil in a temperature enclosed compartment. However, it *should* be protected, and very thoroughly so, from heat generated by the various tubes and resistors in the v.f.o. unit.

This is a problem of mechanical construction and the physics of heat. The first thing is to locate the power supply outside the v.f.o. unit, making it a separate unit, in order to minimize the number of watts of heat we have to contend with. Contained in the power supply can be the voltage regulator for the oscillator, and any voltage dividers or dropping resistors.

While it is not impossible to build a driftless v.f.o. with integral power supply, such a unit is quite an engineering achievement. Rather than spend hours changing the position and size of compensating capacitators, it is much simpler to make the power pack a separate unit.

Either of two types of construction may be employed to keep the heat generated by the r.f. tubes from being radiated or conducted to the oscillator tank.

The first calls for the use of a rather high chassis, with room underneath for the oscillator coil, padding condensers, etc. All tubes and all resistors dissipating more than ¼ watt are placed above the chassis, and the cabinet is well ventilated to minimize the conduction of heat to the components below the chassis. The chief difficulty with this type construction lies in mounting the tuning dial if the tuning condenser is kept below the chassis. However, if tuning capacity is but a small proportion of the total tank capacity, and if the tuning condenser is placed not closer than several inches to any tube, then the tuning condenser can be mounted above the chassis without a serious increase in drift.

The second style of construction calls for all tubes being mounted so that their envelopes project through close-fitting holes in the cabinet, the cabinet being well ventilated as usual. Obviously this calls for the use of metal tubes. To avoid the appearance of a "Goldberg," the layout should be such that the tubes project out the rear of the cabinet instead of out the top or side. The subject of ventilation is treated later in more detail.

The oscillator tank should employ a padding condenser that not only is of the "zero drift" variety, but is inherently stable. Some zero coefficient capacitors appear to have stresses in them which result in instability. Such a capacitor will cause the note to "gargle" a few cycles when listened to on the 10-meter harmonic. Air condensers are superior in this latter regard, but usually do not have as low drift as do high grade "zero coefficient" capacitors of the ceramic and silvered mica types.

To avoid excessive reduction in Q of the frequency-determining tank as a result of loading by the oscillator tube, and also to minimize the drift caused by heating of the oscillator tube elements, the tank either should be made very high-C or else the oscillator tube should work into only a small portion of the tank. The latter can be accomplished by tapping down on the tank or by a "condenser potentiometer" arrangement. The condenser divider will be less likely to produce parasitics than will tapping down on the coil.

Because the Q of a coil goes up (within limits) with an increase in inductance for a given frequency, a moderately low-C arrangement which is but lightly loaded by the oscillator actually is preferable to a high-C tank with the oscillator tied across the whole coil.

The feedback should be no greater than is required to produce oscillation, as excessive feedback voltage reduces the stability of the oscillator. This applies primarily to oscillators not in the electron coupled class.

## The First Buffer

Many amateurs do not appreciate what a large effect the first buffer tube has upon the frequency drift. This applies even when the oscillator is of the e.c. type, though admittedly the effect is somewhat less. Even with loose coupling to the buffer, it is possible for the buffer tube to be contributing most of the drift if the plate dissipation is several times the heater power and the plate dissipation is not maintained on standby. This explains many cases of incurable "oscillator drift."

The coupling to the first buffer should be as loose as possible, and unless the plate dissipation is maintained during periods of standby (or key up conditions when oscillator keying is employed), the plate input should be limited to a value not exceeding the heater dissipation. The tube itself should have high transconductance, low grid-cathode capacity, and low feedback capacity. The 6SG7 makes an excellent first buffer tube for an oscillator not of the 6K8 or e.c. type, delivering over a watt either as a doubler or straight amplifier when run at 250 volts and about 8 ma. This

[*Continued on Page 78*]

# THE GRID DIP OSCILLATOR

## *For Amateur Use*

By W. B. BERNARD,* W4ELZ

A description of a combination capacity and inductance checker, wavemeter, and signal generator.

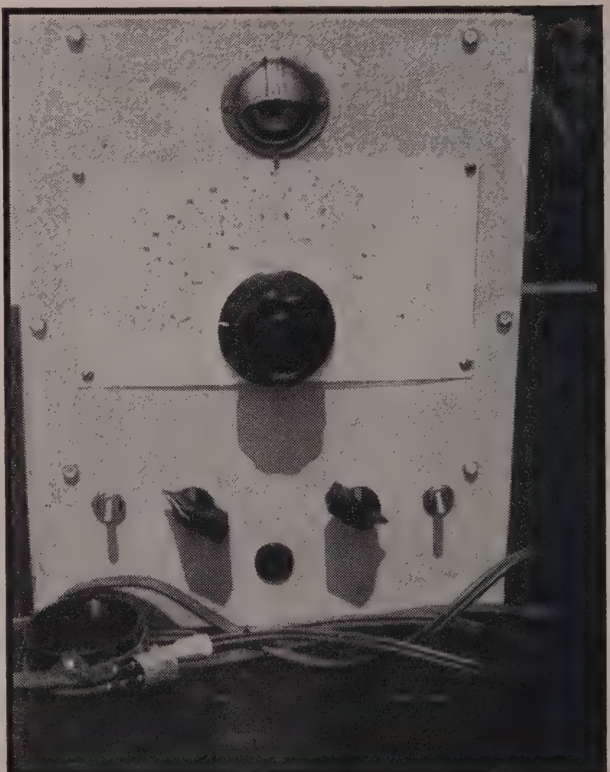
The grid-dip oscillator is an instrument which enjoyed popularity in the past, dropped into oblivion for a time, and within the past few years has been revived again to render service. The manufacturer's literature on a late model led us to believe that it could be a very useful device. So after some delay in finishing up various other projects which had long been in an unfinished state, it was decided to build one which would be adaptable to the amateur's needs.

As usual we started with the best of intentions to buy all new parts and make the device attractive in appearance in addition to being useful around the station. Also, as usual, the vision of first-of-the-month bills began battling with "best intentions." B.i. was putting up a good fight until National Defense joined in and then, since we couldn't get all the parts we desired, we relaxed and pulled out the junk box. Although the finished instrument does not have that "factory built" appearance, it is definitely utilitarian.

### Basic Circuit

Basically the device is simply an oscillator with the output circuit coupled into the tuned circuit. As the load on the oscillator is increased, the voltage across the tuned circuit is decreased, simultaneously decreasing the rectified grid voltage, hence the name "grid-dip oscillator." In the early models the grid voltage

Front-panel view of the multi-purpose grid-dip oscillator.



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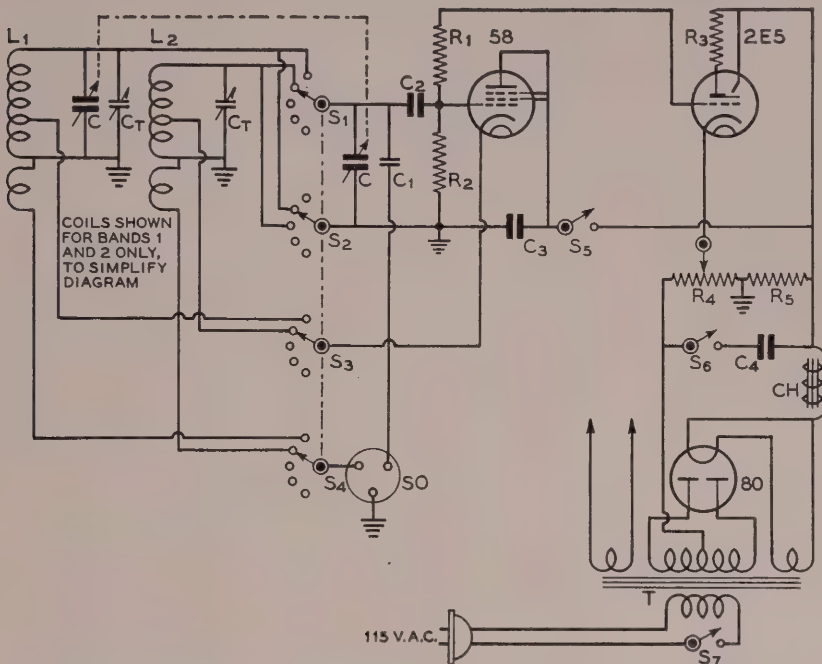



Wiring diagram of the bandswitching grid-dip oscillator.

C—2-gang 450-$\mu\mu$fd. per section
$C_T$—3-30 $\mu\mu$fd. mica trimmer
$C_1$—Twisted hook-up wire, see text
$C_2$—.0001-$\mu$fd. mica
$C_3$—.001 $\mu$fd. mica
$C_4$—8-$\mu$fd. 450-volt electrolytic
$R_1$—1.0 megohm, ½ watt
$R_2$—50,000 ohms, ½ watt
$R_3$—1 megohm, ½ watt
$R_4$—10,000-ohm potentiometer
$R_5$—50,000 ohms, 5 watts
$L_1$, $L_2$—See coil table
$S_1$, $S_2$, $S_3$, $S_4$—2-deck, 4-circuit, 5-position switch
$S_5$—Oscillator on-off switch
$S_6$—Modulation on-off switch
$S_7$—A.c. line on-off switch
CH—Small receiver filter choke
T—Small b.c. transformer, 5 v. 2 a., 500 v. c.t. at 40 ma., filaments for tubes used
SO—Output socket

was measured by a meter reading rectified grid current; since then the introduction of the electric eye tube has simplified the operation of the instrument by eliminating the meter movement inertia which sometimes obscured small dips.

It is well known that with a fixed small coupling between two circuits, much more power will be transferred between them if they are in resonance. This makes it possible to use this oscillator to determine the capacity of a condenser, using a standard inductance; to determine the inductance of a coil, using a standard capacity; to determine the resonant frequency of any series and parallel circuit resonating within the frequency range of the oscillator, including antenna and feeder systems; and by removing the plate voltage from the oscillator it can be used as a sensitive wavemeter. Following from the above we see that the instrument can be very useful in the construction and alignment of transmitters and receivers. Coils can be checked and matched, i.f. channels can be approximately aligned before the receiver is turned on for the first time, and doublers can be checked to see that they are tuned to the correct harmonic.

## Frequency Range

The oscillator covers from 150 kc. to 35 Mc. in five bands. A two-gang 450-$\mu\mu$fd. per section variable condenser is used for tuning. One gang of this condenser is permanently connected across the lowest frequency coil in order to increase the frequency range covered by this coil. The other section of the condenser is switched and is used on all the coil ranges. For the higher frequency bands a smaller tuning condenser might be used so that the spectrum could be covered in a larger number of bands each of which covered a smaller frequency range. Since almost all of the commercially available oscillator coils are of the tickler type, a plate tickler oscillator was first tried and it was found that the variation of grid voltage across the higher frequency ranges was too great to permit easy operation. Grid tickler operation was not tried because of the constructional difficulties presented by insulation of the tuning condenser from the chassis, so the grounded-plate Hartley circuit was finally selected as being best suited to the purpose.

## Coils

The specifications for the coils, except for the lowest frequency range, are given in the table. The lowest frequency coil was made from an old "Litz wound" 175-kc. i.f. coil and the number of turns cannot easily be determined. An inductance in the neighborhood of 1 mhy. is necessary for this range. Most 465-kc. i.f. windings approximate this value so if you can "bum" a defective transformer from your local service man you will no doubt find one good winding which you can use. About 20 to 30 turns of fine wire wound close to this good coil should serve as the cathode section. It may be

necessary to strip a few turns of the winding in order to reach the desired frequency range.

### Power Supply

A small bc set power transformer supplies the needed heater and plate currents. The transformer in our junk box had a 2.5-volt heater winding so the instrument is equipped with 2.5-volt tubes. Any relatively modern triode should do a satisfactory job in the oscillator position. We used a 58 triode connected for the oscillator and a 2E5 for the indicator tube. For anyone starting from scratch, a 6J5 should make a good oscillator and one of the electron eye tubes with two indicating sections, one of which can be connected for high sensitivity and one for low sensitivity, should eliminate the necessity for the adjustment of the delay bias on the eye as the oscillator is tuned from one end of the band to the other and the grid voltage varies accordingly.

### External Coupling

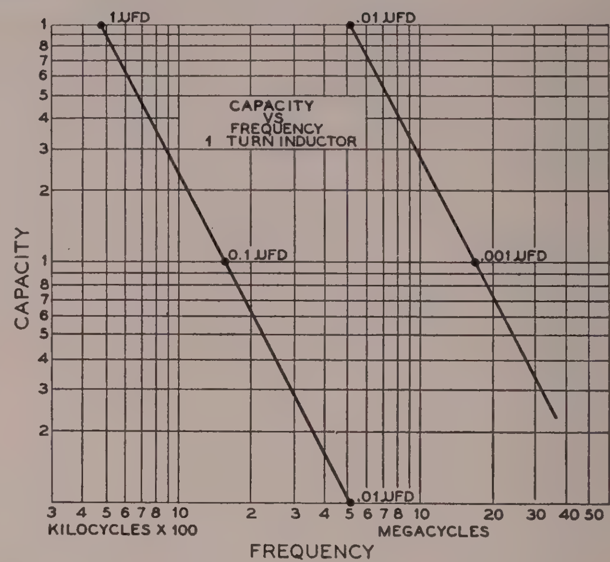
Provisions are made for the use of two types of output coupling, depending upon the nature of the test being made. Inductive coupling is used with the condenser checking inductors and with high frequency circuits, when the mechanical arrangement allows easy linkage to the inductive coupling loop. Capacitive coupling is ordinarily used on low frequency circuits, when it is difficult to obtain sufficient coupling with a few link turns, and on shielded circuits. Since inductive coupling is used most of the time, the dial is calibrated with the inductive coupling cable plugged in.

### Construction

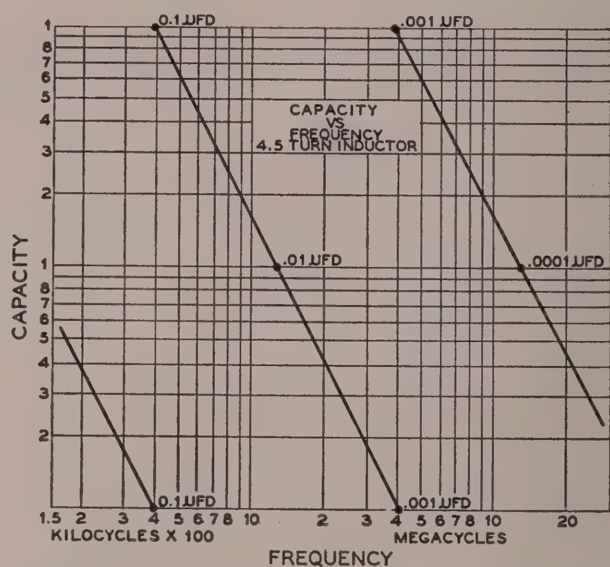
The dial calibrations were made on white drawing paper with India ink and the paper was then covered with celluloid in order to protect the calibrations. A celluloid pointer was attached to a 2-inch diameter skirted knob in order to make a direct drive, direct frequency calibrated dial. A dial having a high reduction ratio will not be very satisfactory on an instrument of this type, since a wide frequency range must sometimes be searched and such a dial would make the search quite laborious.

The instrument is housed in a steel box 11 inches x 5 inches x 8½ inches. These dimensions allow the instrument to be used standing up or lying flat on the bench. A sloping panel cabinet of somewhat larger size might be somewhat of an improvement.

Besides the dial, there appears on the front panel the band switch, the a.c. line switch, the




**Sample Calibration Chart for the 1-turn inductor.**




**Sample Calibration Chart for the 4.5-turn inductor.**

plate voltage switch, and the delay bias control for the eye tube. In addition, not installed when the picture was taken, is the switch for disconnecting the filter so that the output will be modulated and can be easily recognized when it is tuned in on the receiver.

The inductive coupling cable is made of about 3 feet of rubber-covered lampcord. A single turn loop, about 2 inches in diameter, is formed at the end of the cable in order to provide coupling to the condenser checking inductors and other external circuits. The capacity coupling leads are made as short as possible (about a foot and a half) and are terminated in clips. The clip on the ground lead is directly connected to the ground wire; the "hot" clip is coupled to the "hot" lead by

means of a small capacity consisting of about 6 inches of twisted wire. The output of the oscillator is brought to a midget 3-prong socket. The cable being used is plugged into this socket, the wiring of the cable plugs automatically making the correct connections.

### The Coupling Inductors

Two capacity checking inductors were constructed for use with this instrument. One of these consists of a single open turn of brass ribbon ¼-inch wide and about 1/32-inch thick wound on a piece of 2-inch diameter bakelite tubing. This inductor will check capacities from .0005 μfd. to 0.5 μfd.

In using this inductor it is extremely important that good connection be made to the condenser under test and that it be made as closely as possible to the body of the condenser, since in a high-C circuit a very small resistance will lower the Q of the circuit and prevent the instrument from transferring much power to the circuit. Since the inductance is so small, any amount of the condenser leads added to the circuit will make a considerable error in the reading of the capacity.

If the condenser is in a high impedance circuit or has very long leads, it may be tested without disconnecting it. For instance, an audio plate-to-grid coupling condenser may be checked while in the circuit, whereas a cathode by-pass condenser which is shunted by a few hundred ohms resistance must be disconnected from the circuit before it may be checked.

The other inductor consists of 4½ turns of no. 18 d.c.c. wire on a 2-inch diameter bakelite form. The connection to the condenser under test is made by two brass lugs extending from one end of the coil form. This inductor checks capacities from 50 μμfd. to 0.5 μfd. A shallow groove is made in the forms of both inductors so that the coupling loop can be accurately placed each time it is connected to the inductors.

### Calibration

Each of the inductors is calibrated by finding the frequencies at which the eye opens when known capacities are connected across the inductor. The curve of these points should form a straight line when plotted on logarithmic graph paper. Due to the relation between capacity and frequency, when the inductance remains fixed, a nomograph can be constructed with the aid of a slide rule. The slide is removed and replaced backwards so that the B scale runs backwards along the D scale. The B scale then reads capacity and the D scale reads frequency. By setting the slide so that the frequency for an accurately known capacity is aligned with the value of the capacity, the frequency corresponding to the other capacities may be read off opposite the capacity value on the B scale. This may be traced through on thin paper or otherwise transferred onto paper.

The checks made by means of these inductors are of course made at radio frequencies, and a small series resistance which might not show up at 60 cycles is likely to be more apparent at 6 megacycles. As has been mentioned before, a small series resistance will prevent the eye from indicating when the oscillator is tuned through the resonant frequency of the L/C combination and the faulty condenser is thus detected. The high circulating current present may also cause some of the intermittent capacitors to fail when other methods will not show a fault.

The capacity present in transmitter and receiver circuits can be estimated and "lumped" so that coils can be wound and matched and installed without the fuss, muss, and bother attendant to the cut and try method, especially when the connections which must be soldered cannot easily be reached. Variable condensers furnish convenient standards for use when inductances are to be checked; the maximum and minimum capacities of these condensers are usually quite accurately published by the manufacturers.

The operating condition and the frequency of a crystal may be determined by connecting the capacity leads to it. This makes unnecessary the old process of spending the day trimming coils only to find at the end of the day that the crystal was dirty or that the wrong

[*Continued on Page 88*]

COIL TABLE

| Band | Total Turns | Diameter | App. Length | Wire Size | Tapped at | Link |
|---|---|---|---|---|---|---|
| 1 | See text for details of coil | | | | | |
| 2 | 80 | 1½" | 1½" | 26 E. | 10 T. | 2 T. |
| 3 | 35 | ¾" | ½" | 28 E. | 8 T. | 2 T. |
| 4 | 10 | ¾" | ½" | 20 E. | 3 T. | 1 T. |
| 5 | 3½ | ¾" | ⅜" | 18 E. | 1¾ T. | 1 T. |

All taps counted from ground end of coil. All links wound with no. 20 solid hook-up wire.

# A Perfect-Balance Self-Balancing Phase-Inverter

By HENRY WALLMAN*

The phase-inverter circuit of figure 1 is probably still the one most commonly in use. In it the input voltage for tube $T_2$ is obtained from a tap on the grid resistor of tube $T_3$. By locating this tap $1/m$ of the way from ground, $m$ being the gain of tube $T_2$, it is possible to obtain perfect balance, i.e. the "balance-ratio," $E_a/E_b$, (of the magnitudes of the input voltages to the push-pull tubes) will be exactly unity. The circuit of figure 1 has the serious disadvantage, however, that $E_a/E_b$ is very strongly dependent on the gain of tube $T_2$. Thus, even if resistors $R_3$ and $R_4$ are carefully adjusted to give perfect balance with a particular tube $T_2$, considerable unbalance may subsequently occur because of aging of tube $T_2$ or replacement by another tube of the same type; a 25 per cent reduction in gain of $T_2$ will cause a 33⅓ per cent unbalance (an $E_a/E_b$ of 1.33).

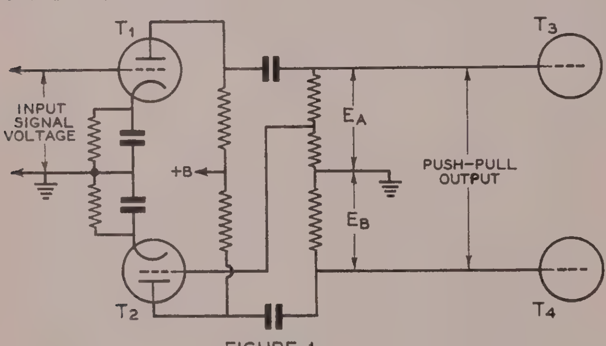



FIGURE 1

The "self-balancing" phase-inverter circuit[1] of figure 2, which is by now well known, was devised to avoid this critical dependence of balance ratio on tube gain. From figure 2 one sees that a considerable part of the output of $T_2$ is common to its input; this means that inverse-feedback is applied to $T_2$. Because of the very large amount of inverse feedback, the gain of $T_2$ has almost no effect on the ratio $E_a/E_b$. This is the reason for the designation "self-balancing." The self-balancing circuit is no more complicated than that of figure 1, and since it is affected so much less by tube variations, there is now no justification for continued use of figure 1.

It seems to be generally believed that the self-balancing phase-inverter has the disadvantage of not permitting absolutely perfect balance[2], and this has undoubtedly turned many experimenters away from the circuit. The fact is, however, that it is very easy to choose the resistors in figure 2 so as to make $E_a/E_b$ exactly 1. It is the purpose of this note, by a simple mathematical analysis of the circuit, to show how this can be done.

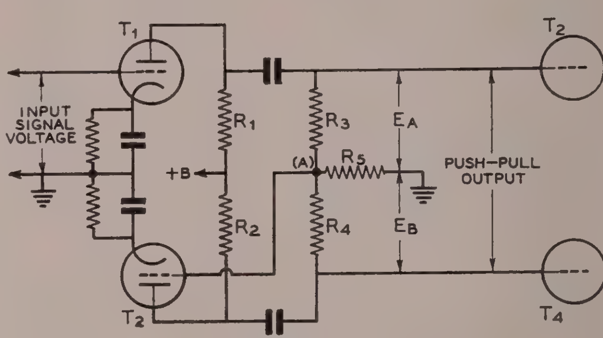



FIGURE 2

In the usual form of the self-balancing circuit, resistors $R_3$ and $R_4$ are equal, and it is, to be sure, correct that $E_a/E_b$ can never be exactly 1 in this case. For instance, $T_1$ and $T_2$ are the two halves of a 6SC7 operated with 300 volt supply, unbypassed common cathode resistor of 1680 ohms, and $R_1 = R_2 = R_3 = R_4 = R_5 = 250{,}000$ ohms, then $E_a/E_b = 1.05$, indicating a 5 per cent unbalance. However,

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[1]See RCA Receiving Tube Manual RC-14, page 24, and RCA Application Note No. 97. This circuit is sometimes called the "Floating Paraphase."

[2]For instance, the RCA Tube Manual, loc. cit., says, "Because of the degenerative action in $T_2$ the ratio $E_a/E_b$ cannot be made equal to unity."

[Continued on Page 89]

# *Five-Meter*
# SUMMER DX

By G. V. DAWSON, JR., W9ZJB/3*

Come August every year someone generally writes up for this magazine the story of five-meter skip dx during the two months that RADIO is not published. Jo Conklin's U.H.F. column started it off with May reports in the last issue and, now that she is flooded with cards and letters, yours truly is pitching in, being just another five-meter ham to leave home for defense work.

This thing of judging how good a year 1941 has been for skip dx is not easy. Sitting down to read the reports and to compare them with the W9ZJB log, the first thing noticed is that a big day for Kansas City may be a small one for most of the country, and the reverse can be true, too. It is due, no doubt, to the "spotty" nature of the sporadic-E layer that gives us all of this fun.

Considering that the sunspot cycle is well down from the 1937 peak, reports are still as voluminous as before, although there are now more reports from fewer people compared with fewer reports from more people as was the case in 1938. Perhaps there are fewer stations than in the final year of modulated oscillators and superregen receivers, but in the less densely populated states there are now more who have come down to 56 megacycles because local population is not necessary when thrill-dx can be raised. There seems to be no doubt, too, that improved antennas, receivers, and transmitters give us "open" days when no signals would have been heard on the equipment used a few years ago. It does not take any more than a 6L6 doubler and an inside antenna to work dx on a really "hot" day, but it is obvious that there is a reason for some of the outstandingly loud boys being the first in and last out, getting in on contacts that just weren't to be had a while back.

One measure of the relative number of openings is the number of days that the band opened. This year, April had a good day for contacts from Kansas City to California. May was open on 15 days—May 4, 7, 9 through 16, 18 through 21, and the 30th and 31st. June was a honey, with reports to Jo Conklin showing dx on 25 days—all but June 3, 13, 16, 17, and 30. So far, the boys have reported dx on only 19 days in July and 3 in August. Later, these figures may be higher.

A measure of the amount of participation in the dx is the number of stations that write in about the band being open on each day, as shown in the accompanying table.

The picture given in this way is rather hit-or-miss, distorting the more recent activity due to the short time for letters to get here and the long time since the last issue of RADIO came out. All but eleven reports were received from W5-6-9, with none at all from W1 where W1HDQ must have a monopoly on the business. Nevertheless, it is apparent from such a tabulation that there was plenty of fun on May 10, 11; June 1, 5, 9, 12, 18, 23, 24, 28, and 29; and on July 2, 8, 11, and 22. Perhaps a more accurate picture is given by the length of calls heard or worked lists submitted, or tabulations of "best" days such as given by W6OVK, who says that they were May 10; June 1, 5, and 28; and July 8, 22. Still another measure would be the number of stations working all districts, a list which is not only growing rapidly but is probably less complete than ever. Several fellows have worked more than three-quarters of the states, while it is said that W9ZHB has worked 43!

But whatever the trend may be, it is certain that the gang has enjoyed another big summer of five-meter dx, and plenty of the boys are waiting around to see if there really is any sunspot cycle as it affects short skip on the ultra-highs.

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*c/o E. H. Conklin, 300 Wilson Lane, Bethesda, Maryland.

TABLE I
Number of reports of five-meter signals, by days.

| Date | May | June | July | August |
|---|---|---|---|---|
| 1 | — | 16 | 1 | 2 |
| 2 | — | 3 | 8 | 3 |
| 3 | — | — | — | — |
| 4 | 1 | 3 | 5 | — |
| 5 | — | 16 | 1 | — |
| 6 | — | 4 | 5 | — |
| 7 | 2 | 5 | 5 | — |
| 8 | — | 4 | 9 | — |
| 9 | 1 | 16 | 7 | — |
| 10 | 16 | 5 | 4 | 1 |
| 11 | 14 | 1 | 7 | — |
| 12 | 3 | 10 | — | |
| 13 | 1 | — | — | |
| 14 | 6 | 7 | 3 | |
| 15 | 1 | 7 | — | |
| 16 | 4 | — | 5 | |
| 17 | — | — | — | |
| 18 | 2 | 10 | 5 | |
| 19 | 6 | 4 | 4 | |
| 20 | 7 | 1 | 5 | |
| 21 | 5 | 4 | — | |
| 22 | — | 2 | 8 | |
| 23 | — | 15 | — | |
| 24 | — | 10 | — | |
| 25 | — | 7 | — | |
| 26 | — | 2 | — | |
| 27 | — | 5 | 4 | |
| 28 | — | 15 | 2 | |
| 29 | — | 11 | 4 | |
| 30 | 6 | — | — | |
| 31 | 6 | | 3 | |
| Total days | 15 | 25 | 19 | 3 |

## June 23

While June 28 is widely held to have been the big day of the year, more letters reached the U.H.F. department reporting openings on June 5, 9, 14, and 23. Several of these were two-hop from coast to coast, and June 23 really gave a lot of the boys the missing ninth district, including W8CIR, W8RKE, W9AQQ, W9CLH, W9YKX, and others.

Practically all of the fun was in the late afternoon and evening. According to Leroy May, W5AJG, the opening in Dallas would rate medium good last year, but for this year it was tops. He started in at 5:35 p.m. Central time and quit at 10:00, finding very good signals as to volume and stability, working W1AVV W2HGU, W3FJ OR CUD GOI CGV HXI ASD IIS W8TIU KDR DDO NSS TDJ HSW QUO CLS CIR OPB W9GGH PK ZHB WTF ARN CBJ RGH IFB LMX.

In Philadelphia, W3DPU logged these on an indoor antenna: W1HDQ W4FBH DXP W5AKI DXW DXB CQV EYZ HTZ AJG ATH. W4FKN in Atlanta found some R9 signals and others erratic from W1-2-3-5-9, but he hooked W1ELP W9CJS USI ZQC OLY. From Texarkana, W5DXW reports hearing W1BPT and raising W1HDQ W2BYM W3OR IIS W4DRZ W8BE CZA CIR W9FFV DWU QCY BMX IOD.

W5HTZ of Cromwell, Oklahoma, called it a good opening when he contacted W3CGV GNA CIT OR GGR BMT GSX ASD W8TIU

Part of the u.h.f. gang at the Trenton, New Jersey, hamfest on August 10, 1941. In the rear, left to right, are: W4EDD, W9ZJB, W3DBC, W3BYF, W3ACC, W3ABS, W3GOI, W3GSX, ? ? ; front row, left to right: W3HWN, ? ? , W3BZJ, W3HDT, W3CUD, W3OR.

CVQ TDJ CLS OPB NSS HSW QQP RUE CZA BFT W9LMS ARN RGH CBJ LLM CGH AQQ QCY BDL and also heard W2-4 stations. The band was open on and off during the evening in Tucson, but W6OVK did not stay on all evening and may have missed some of the best dx. He raised W9OLY CJS IFB AQQ and heard a W8 on 57,350 call him. W8CIR was in most of the evening, but was best while working W8CLS, as the band was going out at 10:00 p.m. Mountain time. Other signals were weak and unreadable. Bud Keller at W6QAP heard W8CIR on and off, also hearing W9AQQ CJS NFM and working W9OLY AQQ IFB.

Up in Oregon, W7ERA hooked W7IFL in Wyoming, W9USI and W9IOD. He also heard W8RKE W9FZK ZQC.

The W8 reports for June 23 come from the Pittsburgh area where W8RUE worked W4HHW DRZ W5HYT ZS HTZ and heard W4EDD DXP W5AKI AJG ATH CQV CHG DNN DXW EYZ FSC W6OVK.

### First W8 W.A.D.

The first station outside of W5-W9 to work all districts, it appears, is W8CIR who hooked W7IFL in Wyoming at 8:45 p.m. Eastern daylight time on June 23. Shortly after the band opened for W5's in Texas and Oklahoma, Ed located W7IFL who was only R3 for an hour except for a short period when his phone got up to R5. Part of the contact was made on c.w. Before the band closed at 1:00 a.m. Eastern daylight time—apparently later than for most reporting stations—Ed had raised W4DSP W5HYT WX CHG FSC ATH CQV AJG W7IFL. The final contact was with W5HYT, who has the most consistent signal at CIR, due, apparently, to a combination of location and equipment.

According to QST, W8RKE's contact was with W7GBI shortly after Ed Doherr beat him to the W7.

### Ninth District Too

Near Chicago, W9CLH is back on five meters in spite of power leaks and all. He hooked W7HEA in Washington on the 23rd for the unworked district. In Iowa, W9YKX got his W7 too, but he did not mention which one it was.

Clair Gould, W9AQQ, got both his W6 and W7 stations on this evening, working W5HYT CHG WX HTZ W6QAP QLZ OVK W7IFL and hearing W4DRZ W7GBI and others who were fading badly. W9QCY in Fort Wayne had less success, working W5AFX DXW HTZ, his three-element beam being down and replaced temporarily with a single horizontal dipole. In Wisconsin, W9WWH worked W4DRZ W5FSC HYT and heard W4DXP W5AJG DXW EYZ CQV W6QLZ OVK W7IFL ERA GBI—a nice gang to hear, but it must be hard to have such terrible luck in raising them!

### June 28

This is the day that has drawn so much attention as the most noteworthy of the year. Let's look it over and see whether it rates more highly than some of the others.

There must have been at least three separate openings on June 28, the first two appearing to be a build-up to the evening two-hop signals. At noon, W6QAP hooked W5HTZ, and at 2:15 he got W9STX. The rest of his dx was at dinner time when he heard W1KLJ AEP LXY (?) SI W2BYM AMJ CUZ and an unidentified W3. W6QAV also heard the W1-2-3 stations. W6OVK had a poor contact with W1SI after he finished with W6QLZ whom he was working during the first 16 minutes of the one hour opening when most of the W1's came through in Tucson.

### First East Coast W7 Contact

According to W2BYM in Lakehurst, New Jersey, June 28 was the banner day in his life, climaxed by a contact with W7ACD which may be the first W7-East Coast five-meter contact as well as the first W7-W2 work. Mel says that the band opened with W4FLH and then swung to W9's of which there seemed to be a million.

Some Eighth District stations from about 500 miles next were heard along with W5WX HYT in Amarillo, Texas, which look like two-hop signals at about 1500 miles. Then Mel raised W7ACD and needed only a two-hop contact with the Sixth District. He was heard in Tucson by W6QAP but did not make a contact. In all, Mel made twenty-two skip contacts, although he spent considerable time searching for the elusive Sixth District station.

### A K7 Contact Too?

A letter from W3OR in Essington, Pennsylvania, asked for assistance in confirming a contact with K7GNN, who is James Sherry in Chichagof, Alaska. While the band was open, W3OR raised this station with the K7 call, and both ends were overheard by W3GOI and W3JIF, the K7 also being heard by others. W3OR does not know whether the K7 was a local or skip contact, but some of the gang at the Trenton hamfest on August 10 said that they thought there was dx fade on his signal. Letters and a message to K7GNN have not as yet brought an answer. *If* this *was* a bootlegger, all we can say is that someone should turn

him in for jeopardizing the amateur bands at a time like this. Fellows, we should be thankful that we can stay on the air, and we should all hope that, if more frequencies are taken from us, some u. h. f. band at least is left on which we can keep up the interest in our field and develop more fellows able to lend a hand in defense work in one way or another.

### Other June 28 DX

Leroy May called June 28 a pretty good opening for W5AJG with signals an average R7 on and off for more than six hours, during which he worked W1SI W4BBR FBH DXM W8NSS QQP DAL W9STX AKF ZHB QCY EGQ KZD LNR UNS RGH ARN KFK ANH IFB. This is mostly single-hop work, so he may have been too close to get in more W1-2-3 work by two hops.

For W5DXW in Texarkana, this was a mediocre day producing contacts with W8FXM W9CJS YKX OLY. Willis heard W1HDQ and W4FLH but, like other W5's the evening opening was no good for W-6-7 contacts, although the Tuscon gang and the W7's both enjoyed two hops into the east.

W7ERA in Oregon heard W9NFM, W9OLY and W9YKX in Iowa working W7ACD. As a matter of fact, quite a few of the Illinois and Iowa gang got ACD that evening. W7FFE and W7FDJ both heard W8TDJ in West Virginia.

W8OKC in Pennsylvania raised W9YKX and heard W2TP W4HWN W5HYT W9ARN STX NFF AHZ but fading garbled other calls.

As for the Ninth District, W9CLH got his second W7 contact which was with W7ACD, and logged all districts but the sixth in two hours of operation; few contacts were made, due to the high noise level at the station.

As for the Indiana gang, W9AQQ in Indianapolis heard that it was the best opening of all, but he did not get on until after eleven o'clock when he worked W5FWS and also W9ZWW in St. Paul, the latter being an unusually short hop. W9QCY in Fort Wayne got W1INF W5BHO DNN FWS HYT W9NFM CJS PKD, these Illinois and Iowa contacts being with very loud signals which appear to be very short skip rather than very long ground wave work.

W9WWH in Wisconsin raised W1HDQ NCQ EKT LSN W4GJO/1 W5HYT and again did better at receiving by logging W5AJG DNN WX W7IFL GBI. W9YKX in Iowa raised W1-2-3-5-7-8 without listing the calls, saying that the band was so wide open on a few occasions that he could work them just as fast as he could sign.

It was a grand opening for W9PKD, who raised W1KLJ HDQ W2BYM W8DDO KKD TIU CTI LPQ FXM QDU QQS IUD ARF RUE QUO CIR W9QCY. Joe thought that with three stations calling him at once, he could not break away to look for W7ACD or the other dx that was on. (What a conscience, my friend!) Anyhow, PKD claims a new record, having worked all four stations in Saginaw, Michigan.

### June 1

Before reviewing reports chronologically, let's look at some of these other days when reports were many, or some two-hop skip was reported.

As for June 1, in addition to the material in the last issue of RADIO, W5AAN in Denton, Texas, hooked W8MSS (NSS?) VIB ARF KKD DDO KGC TIU W9PK and logged W8QXV QUO PMQ. W5HTZ got into the same area, hooking W8QXV FGV QUO QQP JLQ ARF DDO HSW KQC KKD VIB TIU RKE W9QCY. W5AJG did not do as much, working W8TIU VIB W9PK WWH PMQ.

In one of the few reports from Clyde, we learn that W6QLZ heard W8CIR on two hops, but he had to work and could not be on the air. W6SLO worked two-hop over the heads of the W5's and into the same area, raising W8CIR CLS OPB CZA QXV QQP W9QCY. He heard some Fifth District stations too. W6PCB heard W8CIR while he was up in the Rincon Mountains.

The W9's were in on this more than the above reports show, even W9ZJB, who heard W8CIR CLS CZA QQP weakly. W9AQQ reports W5HYT's signals strong both ways. W9QCY got W5HTZ WX on one hop, then W6SLO on two hops. W9WWH heard W5EYZ and worked W5AJG HYT. Similarly, W9PMQ, who is also in Wisconsin, raised W5AJG and heard W5EYZ HYT. It was much better for W9PKD, who finally got a whack at the five-meter band, saying that a few more days like June 1 would get him off the bottom of the honor roll. He raised W8CLS CIR QXV OPB QQP and heard W8NSS JLQ KKD.

This day seems to be one on which there were two patches of sporadic-*E*, enabling W6SLO to bounce his signals into southern Kansas and northern Oklahoma from where they bounced mainly into Michigan and Ohio. That probably accounts for his hearing a few W5's. The eastern patch of layer, then, was large enough for the northern Texas stations to use it to the same points as did the Oklahoma boys and W9PKD in Kansas, the Wisconsin stations getting in on the western edge

of the patch. Boy, can't you almost see that layer hanging around over the state of Illinois from the Indiana line over into northeastern Missouri?

### June 5

Now how about June 5 which made itself famous a few years ago before the last week in July took all of the glory?

W5AAN found the band open for two hours around noon and nearly five hours in the evening. He worked W8KDR QQS LZN QUO TBN CIR AKE W9WWK ZHB DYH LLM LF IOD QCY RRX PMQ. It was not such a bad day for Leroy, W5AJG, who got W3HFY W8QQS KDR TBN CLS CVQ QUO W9PQH UDO in the morning, and W7GBI W8UOS KQC ARF BIQ DDO TIU KKD VIB CVQ LZN QDU RKE OPB CLS QQP W9IOD ZHB WCD CLH PMQ PK OLY RRX LF WTF AKF in the evening. His contact with W7GBI gave him all districts in 1941, not counting the cross-band contact with W7ACD reported in the last issue.

In Oklahoma, W5HTZ first raised W8RFW UOS QQP PK DDO LZN QDU TIU CIR CVQ KQC RKE VIB KKD CLS QQS ARF W9OBW DQU ZHL WWH IOD QCY ZHB WCD LLM PMQ KEW UDO DYH and then turned his beam west for a contact with W7IFL in Cheyenne for the missing district to give him W.A.D. or, as Ed Tilton puts it, W.A.C.A. W7IFL told Merlin that he had been hearing W8-9 but had only three contacts.

Down in Camp Clarborne, Louisiana, W9BJV/5 has received the call W5JXS. He put it to good use on the 5th, hooking W8TIU RFW W9YDC AHZ DYH WWH PK ZQC YKX CJS QPK CCY QIQ and hearing W8VIB RKE W9IFB OLY ZHB CLH OFL IOD LLM WCD PQH NYB RRX.

### Transcontinental DX Again

In Tucson, W6OVK says that he worked his first W1's on June 5 along with W6SLO who managed to sneak in ten minutes early in the evening to grab off two of them, W1AEP HDQ. The band was open almost all day, SLO and QAP working W9's around noon. OVK worked W1HDQ AEP EKT W5AFX W8QKC W9GHW NYV, and he thinks that he got to W1KLJ. W1AEP HDQ were R9 plus for twenty minutes or longer, HDQ being the strongest from his district but AEP stayed in longest, allowing time for two contacts. Jim also heard W1DLY W2KLZ W8QDU and many others that he was unable to read. KLZ was in for almost an hour but OVK could not connect. OVK got heard cards from W2KLZ and seven W1's. Jim experienced his first QRM on this opening, especially on the low edge and at 57 megacycles. Clyde, W6QLZ, gave us his last report of the summer on the 5th, on which the band was open from ten in the morning to about seven in the evening with all signals except W9QPK very poor. However, Clyde did hook W8CIR W9YKX NFM QPK GHW and heard W1LSN HDQ I?Y or IY? W3HFY HWN IIS W9??V OLY CCY ZQC USI and another W9 about 57.5 megacycles.

In Shelley, Idaho, W7ACD put the morning to good use by working W9GHW AHZ NYV ZHB IFB NKW WAL, thus giving the St. Louis gang a lot of W.A.D. stations. ACD says that he would like to contact some W6's—oh yes, there are some boys in the east who would, too, but his chances are better.

In Pittsburgh, W8RUE heard W5VV HTZ AJG ANN but did not make any contacts. W8PK near Rochester, New York, hooked W5AFX HTZ W9OFL OLY NFM and heard W9USI QPK. 9AQQ had next to his best day of the year, raising W5VV AFX FWS HYT AJG W9QPK and also logging W5WX CKH EIJ and W7ACD. As for W9QCY, his log for June 5 shows contacts with W5EHM VV HYT CHG AFX HTZ AAN W9QPK. W9WWH had his best day except for the five times he logged Seventh District stations, working W1LLL AEP AW JTB GJZ INF DLY W3GUF W5AFX HTZ AAN HYT VV EYZ W9BJV/5 and hearing W1KXK HDQ W3OR W8PK, etc. Yeah, get that "etc."; it must have been a hot day.

### More W.A.D.

Before leaving for the draft, W9NLR sends in the report of activities at W9ZQC in South Dakota, where the boys finished up a contact with W2BYM on June 5 for their Ninth District, making W.A.D. in twenty-five days. This day was their best up to the 15th, bringing contacts with W1AEP LSN HDQ LLL AW (really?) W2BYM W3OR ASD W4FPM W5VV JGV EYZ W8FGV W9BJV/5. What they needed that day was a six and a seven.

Also, W9CJS got his nine districts by hooking W3BKB.

For five hours, W9PMQ enjoyed his best day up to this time, hooking up with W1AW JTB W3GUF W5AJG AFX DXB ATH EYZ HTZ AAN VV and logging W1DLY KSA HDQ BHS LLL W5FWS BTW HYT W8PK.

Bill Copeland, W9YKX, was fit to be tied, he says, when he tried without success to hook W7ACD who was too busy with others, but he did make some well separated contacts with every other district, including W1LLL AEP W2KLZ W3ASD W4FBH FPM W5DXB

ATH EYZ VV W6QAP SLO QLZ W8FGV W9BJV/5. It must be something to sit down to a five-meter rig and hear all districts, working eight of them before getting up. Certainly such a day should be listed among the better ones.

### June 9

Here is another day about which few praises have been heard. The reports on activities of June 9, however, come from almost every part of the country. Starting in the upper right hand corner and going around, W2BYM was worked with better than an R9 signal and W1CON W3GHY GWT DMR were heard by W4FKN in Atlanta during a spotty opening in the evening. W5AJG also called it poor and spotty, but he raised W8RKE QDU W9WDV. Merlin Berrie, W5HTZ, did not do so poorly, working W8QXV QQP QUO CIR W9WDV WWH RRX UDO.

Out in Tucson, W6OVK found the opening north only, although he and W7ERA in an R9 plus contact agreed that the ten-meter band was not active between them. OVK was hearing W1-2-3 working short skip, which led him to say that they probably were having a great time on five meters in the east. In addition to the W7ERA contact, Jim heard W7FFE. Besides the W6OVK contact, W7ERA raised W9ZQC, and heard W9JWB on c.w. W7FDJ hooked W9ZQC at nine o'clock, and W7FFE got W9ZQC CJS on the same evening. Another W7 who had some fun was ACD who worked W9CJS DYH.

Out there in Kansas City, W9ZJB was also working a little dx—very little, just W3GUF. In South Dakota, W9ZQC/NLR completed the circle, raising W3BKB W7FFE ERA FDJ and hearing W7ACD W9APQ (?). W9YKX also got to the W3's but missed out on the W7's who were getting to both sides of him. W9WWH got in his usual Fifth District list, snagging W5HTZ and logging W5DXB HYT AJG AFX EHM FSC.

W9AQQ got only W5WX and heard W5DHO, while his Indiana neighbor, W9QCY, raised W5WX HYT.

In Pittsburgh, W8RUE got in on the eastern work mostly, hearing W3IIS W4DRZ DXP W5AFX HTZ W9UZH.

Looking back, perhaps the only trouble with June 9 is that there was too little activity in the many places where the band opened, except possibly for the W7's who were well represented.

### July Openings

According to our correspondence, July was open only about seventy per cent as much as June, there being 19 open days as against 25. Also, there are not as many reports, but more letters were received giving logs for July 2, 8, 9, 11, and 22 than for the other open days in the month.

### July 8

According to W2BYM, July 8 was the night that W6OVK came through to W3's near him. Jim worked W3OR CGV W8CIR QUO and a lot of others west of them. He also heard W3BKB. So, to the extent that the day produced some transcontinental dx, it is worthy of some special note. Two-hop work also took place on July 22, but not quite so far east. Other contacts of OVK on the 8th are W5AFX W6BPT W9BDL ANH AKF VQU PKD AB UWL. He heard W8RKE QQS W9ZHL in addition to W3BKB and lots of others not identified.

In nearly three hours following 6:15 p.m. Mountain time, after which he left with the band still open, W6QAP raised W5AFX HTZ W6BPT W8CIR KKD QQS W9UWL and logged W3AXU CGV BKB OR W8PQ? QUO RKE RFW VIB W9ANA BDL ZHL DQU QCY YKX OLY PKD. W6SLO hooked W5HTZ W6BPT W8KKD W9UWL BDL BPN.

W5AJG had a three hour but spotty opening with signals good at times, in which he snagged W3CGV W8KQC ARF FXM KKD PK QUO FYC DDO LZN LRE NSS QXV NYD W9LMX JPB DWU.

A New Mexico contact with W5JGV was made by W7ERA.

Joe Addison, W9PKD, improved his Honor Roll standing by making a contact with W6OVK off the back of his beam. He also heard another Arizona station weakly. Joe was probably looking for those Eastern stations that he was missing, for he had found W5-6-8-9 coming through on ten meters.

W9AQQ did not make any contacts but said that the band was open to W5-6. This fellow W9ZJB was also on working himself some dx, W3CYW in Virginia.

### Early August

Reports to the moment of writing mention openings on August 1, 2, and 10 with the first two being fair ones. We shall have to reserve judgment on the rating of the month until the next issue.

### Daily Reports

So far, only a relatively few open days have been reviewed, picking some of the better ones. There have been additional May reports since the last issue, however, and many from the lesser days in the other summer months. Let's

look them over, one day at a time.

*May 4.* W9PKD had a brief contact with W8QQP for his first five-meter dx. W9ZJB heard someone on 57.1 megacycles.

*May 10.* This was a very fine day for a large part of the country, reported in considerable detail in the July issue. These later reports are included here as a matter of record. Walter Manning, W7ERA, had contacts with two of the Tucson gang, W6OVK and W6SLO. W9ZQC/NLR of Brookings raised W6QLZ OVK QG ANN, the last two being out on the coast; they also heard W6QUK W9BDL. W9ZJB contacted W3CUD GUF OR W6PBD QLZ W8KQC QQP SGV TTL. In Wisconsin, W9WWH heard W4MV FVM FBH W5BDB DXW. W9QCY got only W5AJG.

*May 11.* This was another good day for some of the boys who got California contacts out of it, as discussed in the last issue. Later data indicates that W9ZQC/NLR worked W5HYT HTZ AFX W7GBI and heard W5WX CHG W8NYD; also, W9ZJB heard W6's in Arizona and W7IFL in Wyoming.

*May 14.* There is not much more to add about this day—just that W9ZQC/NLR heard W7HEA/7.

*May 15.* Two W1's were heard but not identified by W9ZQC in South Dakota.

*May 16.* The band was open at W5AJG in Dallas, but Leroy heard only W3IIS. Another isolated report is of W4FBH being heard at W9WWH. These look like a couple of small patches of layer over Tennessee.

*May 19.* Just like on the 10th, W7ERA worked W6OVK SLO with the same R9 and R8 signals.

*May 20.* In a three-hour opening, W5AJG connected with W8TIU QQS CVQ FXM W9AQQ DYH QIN ZQC DWU. It seems that W5VV generally works the same stations and, if he gets there first, he asks them to tell Leroy "Phooie." Well, now that Wilmer is in the Air Corps, even though it is radio work, someone may apply that old one to him—"You don't have to be crazy to be in the Air Corps, but it helps a lot." Getting back to business, W9ZQC/NLR raised W5AJG VV EHM.

*May 21.* W9ZQC and his draftie partner hooked W5EHM VV W6QLZ and heard W5AJG JGV. W5VV worked eleven stations but AJG got only three, W9NFM USI CJS in Iowa and South Dakota. Leroy may have been too far north. W9QCY in Fort Wayne raised W5VV BNN.

*May 30.* After that long stretch of dx in the middle of the month, the hiatus came on and a break was welcome in the last two days. W5AJG worked W9HAQ KZP and heard W6OVK. W5HTZ missed the first part of the two or three hour opening when he heard some W8's come through on a converter while he was away from the transmitter, but he got home at noon to work W8QXU KDR ARF QUO QQP NSS CIR KKD OMY QXV JLQ W9BDL. W9BJV/5 who is now W5JXS in Louisiana hooked W8RKE RFW in Grand Rapids and a W8?? in Saginaw. Then he got W9NFM UTZ HAQ in Iowa and DWU in Minneapolis. The W8 signals were poor, but the 9's were R9 plus. In Milwaukie, Oregon, W7ERA raised W6QG and heard W6ANN down the coast.

*May 31.* W7ERA worked W6QLZ OVK this time. QLZ also worked W7FFE AMX FDJ. With the ten-meter band open to W3, W9ZJB dropped down to five, expecting to get an eastern contact but instead he had a good chat with W5VV.

### More June Data

*June 1.* This was one of the days reported above in some detail.

*June 2.* Rather a let-down from the day before, but W9ZQC/NLR did some nice work toward the east coast with W1HDQ AEP KLJ LLL W8PKJ. W9AQQ heard carriers at around noon, but he had no further luck, apparently being on the southern edge of the skip. W9PMQ heard only W5HYT. W9ZJB heard something on 56.6 megacycles.

*June 4.* W5AJG heard W8TIU but thought that the band was bound to have opened in other parts of the country. He was barely right, for W9AQQ heard W5VV without making contact, and W9YKX said that he heard W5's.

*June 5.* See above for details of this day.

*June 6.* W5HTZ in Oklahoma heard W6QLZ for a few minutes. W6SLO hooked W9NFM ZHB and heard W9FZN. W6OVK got the best of the deal in Tucson, for he hooked W9NFM HAQ ZHB FZN YKX and heard NKW GHW, signals reaching R9 on peaks. Jim heard harmonics from ten meters for an hour with the beam pointed northwest, but he could not locate an active five-meter W6-7. W8RUE heard W5HYT. W9YKX found the band open to the sixth district.

*June 7.* Dallas was represented in this opening by W5AJG who connected with W2BYM W3HDJ HFY AXU. W5HTZ did not work many, but they are choice: W1HDQ W2AMJ W3HFY. W6OVK heard W7FFE ERA but did not hook ERA until the band was about to go out. W7ERA also heard some harmonics of W9's from ten meters, so there was an opening going to waste, possibly to Colorado or thereabouts. W9YKX again found the band open to the Sixth District.

*June 8.* The best signals of the summer up to this date were reported by W6OVK who raised W7FFE FDJ HEA ERA and logged W7FLQ. W6SLO raised the same four stations. W7ERA got these two and also W6QLZ.

*June 9.* This day is reported above.

*June 10.* W5HTZ hooked the Arizona boys, W6QLZ SLO OVK. This was the sixth consecutive daily opening for W6OVK, who worked W9YKX, whose signal stayed up to R9 plus for half an hour, then added W5HTZ AFX W9HAQ. Jim heard W9NYV NFM QPK. W6GBN raised W5HTZ W9QPK in his first dx and heard W9YKX and some weak carriers. W6SLO raised W5HTZ AFX W9YKX. This was only another W6 opening for YKX.

*June 11.* For the seventh consecutive day of five-meter dx, W6OVK heard W7CIL.

*June 12.* Although W5AJG calls this day poor and spotty for three hours, working W9QCY PK NYV ZHL HAQ, there are quite a few reports for it. It was the seventh district again for the eighth open day at W6OVK who got W7FDJ FFE at dinner time with R9 plus signals both ways, although there had been no indication of an opening that way; later, ten meters opened to W5 and W9. W6SLO raised W7FDJ and heard W7ERA. ERA worked W5JGV and heard W6OVK. W8RUE heard W5EHM late in the evening. W9AQQ hooked W5EYZ FSC DNN, while W9QCY contacted W5FSC BHO DNN AJG. W9WWH heard W5AJG EYZ DNN EHM. This was also about the day that W4FKN worked W5HYT, but the card does not say definitely.

*June 14.* In the morning opening on this day, W5AJG raised W2BYM W8BJG DDO RNP with fair signals. At six to seven p.m., he got W8NSS QYD DAL OMY BPQ RUE with fair signals again. W5HTZ had poorer luck, hearing W8QXV who faded out during a CQ. W6OVK and W6QLZ heard W5DXW AJG in the early evening during the ten-meter double hop to W5-8-9. W8RUE and W9WWH heard W5AJG EHM. Weak carriers were all that W9AQQ logged. After four blank days, W9ZQC/NLR hooked W7FLQ GBI.

*June 15.* W9ZQC heard W9QCY for half a minute. W9QCY raised W5DXW. The latter worked W8KKD UJE W9QCY and heard W8JLQ. W5AJG worked only W8JLQ and heard no more signals. W5HTZ did better, working W8WAD RUE QYD NSS and hearing W8CIR as the band faded out. W8RUE worked W5HTZ and heard nothing else. W6OVK worked W6BPT in a short opening to upper California, for the eleventh out of twelve days that he worked five-meter skip dx.

*June 18.* After two dead days, a fair one came along. W4FKN found the band open for two and a half hours, but he had to be away most of this time. He raised W9DYH CJS YKX ECO (who used f.m. and who was the loudest ever heard at FKN), and heard W9FFV DWU and others not logged. In two hours, W5AJG worked W8QDU DDO RUE CIR RFW JLQ WED KKD VFI W9IOD AKF ZHB with quite good signals around R8. A good opening was also reported at W5HTZ, who hooked W8QQP LZN QDU VIB ARF TIU JLQ DDO RFW KKD PKJ VFI POL GU FGV CZA QXV W9AB IOD AKF. W6OVK heard weak and fading signals calling "CQ 5" but did not identify a one of them. W8RUE worked W5AJG and heard W5HYT AFX EHM. W9AQQ in Indianapolis raised W1HXP W5HYT WX and also W9YYT in Colorado. W9QCY snagged W5HYT AFX W9USI CJS. W9WWH in Wisconsin hooked W5HYT and also logged W5HTZ EHM. W9YKX got in only on the Fourth District.

*June 19.* Only the western districts were heard from this time. W6OVK found the band open now and then for two hours in which he raised W7ERA twice and W7FFE once, as well as hearing W7CIL FDJ. W6QAP duplicated OVK's work exactly, while W6SLO raised W7FDJ and heard W7CIL. W7ERA heard none other than the three Arizona boys.

*June 20.* This day would have been blank had not W6OVK heard W7FLQ trying to raise some local stations. Jim says that the Oregon boys are usually R9 when FLQ comes through.

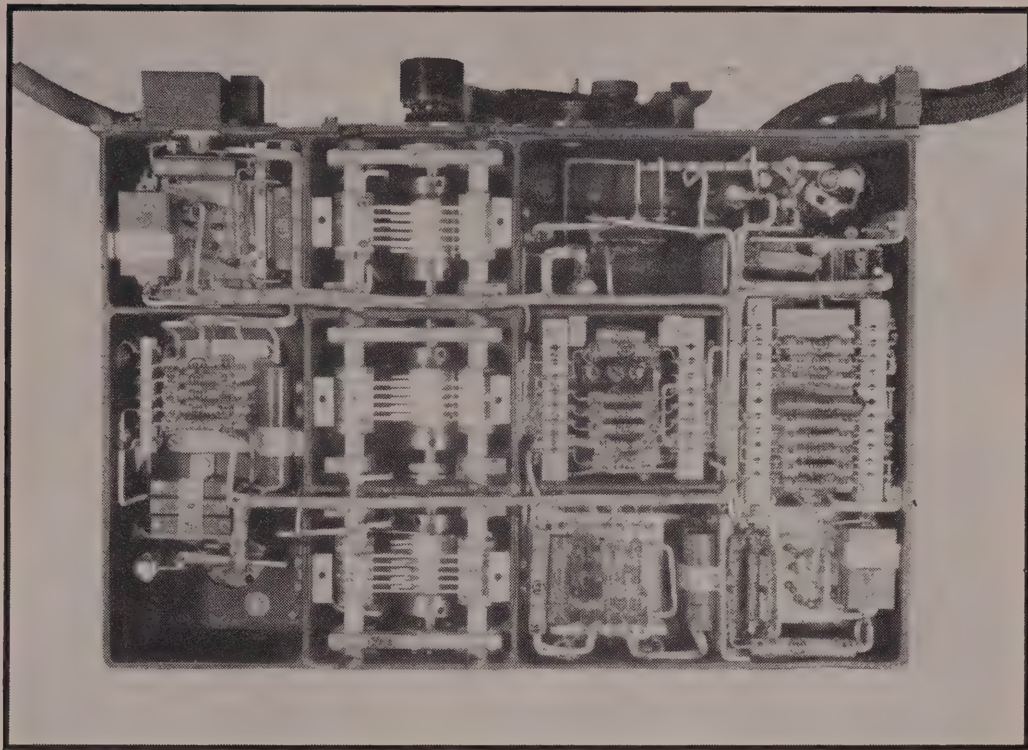
*June 21.* In a poor opening, W5AJG raised W8RKE TIU W9WWH PK CJS. W5HTZ heard some signals but had to leave the house. W9WWH hooked W5AJG HYT AFX and heard W5HTZ. W9YKX says that the band was open to W5 for him, too.

*June 22.* On this day, W5HTZ heard a lot of signals that were in for only a few minutes at a time but he did connect with W1KLJ and W8PKJ. Without hearing a thing on ten meters, W9PKD in Kansas contacted W8FGV QXV QQP and heard W2HWX on five meters.

*June 23.* This one, too, is covered above among the outstanding days.

*June 24.* Not a bad day, this, although it suffers by contrast with the day before. In the morning, W4FKN worked W9SQE YLV during poor conditions. Speaking of conditions, SQE really has some to put up with, being down between two apartment buildings in a dense part of Chicago. W5AJG found the

[*Continued on Page 80*]



● Bottom view of the receiver used in the Messerschmitt 109 fighter plane. While the workmanship is excellent, the design is vintage of about 1933. Tubes similar to our type 24 or 35 are used throughout for r.f., i.f., detectors, and audio. Photo by courtesy of Lear-Avia.

# DEPARTMENTS

- **U. H. F.**
- **The Amateur Newcomer**
- **Yarn of the Month**
- **What's New in Radio**
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# U. H. F. . . .

By JOSEPHINE CONKLIN,* W9SLG/3

Another summer—for some a vacation and for others not—has slipped by. It was a summer in which a somewhat different gang was in on both skip and extended ground wave dx, at least as reported to us. This year, most skip reports came from W6OVK where as last year it was W5AJG and before that W6QLZ, W5EHM, and others. Now W5EHM, W8QDU, W8GU, and W9CLH are back working the dx while W8CIR, W5AJG, W9ZHB, and W6QLZ continue to be in on many openings. Some relatively new dx hounds have been "going to town" this year, including W6QAP, W9PKD, W8RKE, W9CJS, W5HTZ, W5HYT, and many others. Not that they haven't worked dx before, because most of them have, but their work has come to the front. Also, several other calls have been working toward the top of the Honor Roll, including W9ZQC/NLR, W9WAL, W9AQQ, W9GHW, W2BYM, W5DXW, W4FKN, and others that will be recognized in the five meter Honor Roll in this issue. Some calls that probably should be up in the eight-district-worked column but who have not yet provided the data are W1AEP EKT W3OR W8CLS QXV QQP CGV QUO KKD W9BDL UWL. What is the dope on these and others?

The story of skip dx during the summer appears elsewhere, being the result of a cooperative study of the reports, and carrying the signature of Vince Dawson, W9ZJB/3, who is now working in the Radio Branch assisting Bill Conklin, W9BNX/3, in the Navy Department. Vince was able to get one of those "Radio Technician" jobs that carry a sub-professional rating not requiring an engineering degree. Even so, it nets him twice his Kansas City salary, which he can spend on the old High Cost of Living in Washington!

In order to devote the available space for the column in this issue to such matters as are news only when it is fresh, the technical comments sent in during the summer will be held until next month. Ordinarily there would be a lack of material for November inasmuch as it is generally prepared before the October number gets into the hands of the u.h.f. gang, reminding them to write to us. Anyhow, if you did send us comments on how well your concentric line converter is operating, or what kind of an antenna you feel is best, please look for the dope next month.

*300 Wilson Lane, Bethesda, Maryland.

## F.M.

At the I.R.E. convention in Detroit, Bill Conklin was interested in Crosby's comments that f.m. dx can become unintelligible as much as 50 per cent of the time if two or more signal components reach the receiver. Sporadic-*E* layer skip on five and ten meters, when only one-hop signals come through, may not present this difficulty. W4FKN said that W9ECO using f.m. on five meters last June 18 was the loudest station ever heard on the band. This column would like to receive reports of *every* skip f.m. signal received on 28 or 56 megacycles, with a comment on clarity and whether the speech sounded like "double talk" or had a variable whistling interference on it, or had a peculiar variable type of harmonic distortion.

Where f.m. signals are very loud, such as in local work, near a b.c. station, or for monitoring purposes, it is said to be possible to get good signals with a special one-tube receiver. This receiver uses two tuned circuits, one tuned on each side of the signal to give discriminator action. It is probably broad unless highly selective circuits are used.

Another stunt that may be of interest is phase modulation, which can be heard as a.m. or as f.m. One use for it is to put a tone on c.w. signals on the five-meter band (or elsewhere where permitted) in order to eliminate selective fading (have you ever heard any on one-hop dx signals?) or for whatever reason tones are put on keyed signals. Just arrange the crystal tube cathode circuit to take a small audio voltage through a transformer, and let the resulting phase modulation multiply in the doubler stages. A little goes a long way.

## Extended Ground Wave DX

But we were not going to go into the hint and kink business this month. So let's look over some of the good work that has been done without the help of the ionosphere.

In Woodbine, Iowa, W9YKX was doing good work all winter with W9ZJB in Kansas City at 206 miles, and in the spring with W9NFM who is 235 miles away at Solon, Iowa, the western terminus of the "Central Illinois (horizontal) Net." Aspiring to even greater heights, Bill Copeland put up a 12-element horizontal beam and got the feed line

standing waves under control. W9ZHB in Zearing, Illinois, heard Bill's carrier for several days after the new beam went up and a successful two-way contact was completed at about *355 miles* with no one even on a little hill! The beam raised YKX's signals two R's over his old beam, according to NFM, but some of this may be due to improved conditions at the time, for there has been no repetition of the 355 mile contact reported to us. That was nice work, Ed and Bill. Now Ed can go to work on W9RBK in Kentucky and the Eastern Michigan-Ohio gang.

While still talking about the good old Ninth District, let's look over some of the good work done at W9AQQ in Indianapolis. On June 8, Clair Gould made his first contacts with W8QDU in Detroit and W8JLQ in Toledo. Our impression has been that AQQ uses a horizontal antenna, and rumor has it that the old vertical man, W8QDU, has been forced to give it another try due to the "spread" of the Central Illinois gang using horizontals. W8JLQ started out with a nice stacked plumber's delight but could not work the Michigan and Ohio verticals, so he changed over. No word has been received here as to which he is using now.

Anyhow, on June 18, AQQ had a contact with W9ZHB across half of the states of Indiana and Illinois, and on the next day he got W8VIB in Three Rivers, Michigan. Ground wave work was rather good most of July, with contacts at 200 to 300 miles on quite a few evenings, especially on the 29th when he worked the first skip dx to W1 in two years, and had several W8-9 contacts up to 300 miles. W8QUO of Toledo puts in one of the best signals for his distance. As Clair was writing his report on August 13, he was working W9RBK of Newport, Kentucky, who is on 57.4 Mc. and comes in R8 and R9 in Indianapolis.

Upstate in Fort Wayne, W9QCY went back to a three-element horizontal beam (only 25 feet high) on August 1. Possibly with both polarizations, he has had ground wave contacts with W8QQP QDU NSS KQC KKD VIB QUO JLQ CVQ CIR ARF NYD QXV W9LMX AQQ HQV KAQ BDL ANH OMR RRX CLH AKF WDV PK ZHL IOD VPN JPB LLM YLV VZP.

In Racine, Wisconsin, W9WWH has been working out to 125 miles fairly consistently. He thinks that ground wave signals are stronger from 100 miles during sporadic-*E* skip this year, whereas they could not be heard last year. Perhaps he has a better receiver or antenna, or there may be some other explanation. Lettsome has heard W9QCY HUV AQQ LMX in Indiana but has not yet worked that state. W8RKE in Grand Rapids across the lake, using a vertical, is heard on WWH's horizontal W6QIZ four-element beam, but RKE only occasionally hears WWH and makes a contact. W8CVQ in Kalamazoo, who is reported to be using a horizontal, now comes through on Monday and Friday evenings and has been worked, as has W8VIB in Three Rivers. WWH has worked W9NFM HAQ in Iowa on aurora, but has not heard Iowa or Minnesota stations on low atmosphere bending.

Over at W3AWM one night in early August, W9ZJB heard locals in Washington working all the way up to W1HDQ, said to have been using horizontal polarization at the time. Charlie, W3AWM, got up into Pennsylvania, and reports some improvement now that ZJB has encouraged him to replace his "J" antenna with a matched extended double zepp.

When Bill Conklin called at W8CIR about 5:30 a.m. (but CIR was on daylight saving) on June 25, Ed mentioned using two antennas, one horizontal and one vertical, to work ground wave with anyone. Next, someone will mount one antenna tilted 45 degrees so that it can be received on either polarization—with a probable loss of 3 db.

In Detroit, W8KQC said that his tests with W8CIR and others show that a crystal filter definitely should be used to pull through the 200 mile signals when other locals can't hear the extended ground wave signals through the receiver and outside noise.

W5AJG HTZ DXW BDB AAN EHM AFX have been working ground wave in Northern Texas, Oklahoma, and Texarkana. W5EYZ in Fort Worth was heard weakly at HTZ, about 185 miles, some of the other hops being about 165 miles. W5AJG worked W5VV before Wilmer left Austin, close to 200 miles away.

W5EEX of Houston dropped in at W6OVK and W6QLZ, working the rig at the latter in a ground wave contact with OVK. He was reported to be impressed by the signals across the mountains and hoped to be back on the band in Houston by August. Now that the Texarkana and Dallas boys are working by ground wave, any signals from W5EEX will probably be welcome.

### Five Meter Rigs

Travis Tittle, W5AAN, has been using 600 watts into a pair of 100TH's in ground wave and skip dx this summer. W5AJG has a 30-watt rig on a low beam and 300 watts on a high beam, about which he has been learning some interesting things.

[*Continued on Page 92*]

# *book for 1942!*

Here's the book that couldn't wait for 1942! The eighth edition of the famous "RADIO" HANDBOOK—completely revised and brought up-to-the-minute for you! Careful editing makes any other handbook ever printed as out of date as a WD11!

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# METER-SWITCHING
## For Transmitters

By JOHN R. GRIGGS, W6KW

In these days of National Defense priorities, one of the first shortages the newcomer bumps up against is that of suitable meters. And necessity being the mother of invention, we therefore must look about us to determine ways and means of surmounting this obstacle in our design and construction of new equipment.

For years, we have taken meter switching in such equipment as tube testers entirely for granted, not thinking much of how we could turn that feature to maximum benefit in an amateur transmitter. In fact, best engineering practice has always held to the maximum quantity rather than the minimum quantity of meters so that every circuit could be metered for constant check.

But this feature is not so important in amateur transmitters. Therefore, meter-switching offers not only a way out during this emergency, but also a method of obtaining accurate checks on every circuit of a transmitter at a minimum of cost, i.e., one meter and a switch.

One transmitter designed for the amateur which incorporated meter switching was the author's "Mighty Mite" which used the meter switching circuit shown in figure 1. It will be noted that three plate circuits can be checked with this method, but since the switch and meter are placed in the positive lead, it can only be used in a transmitter where all plate circuits are supplied by one plate supply. In the Mighty Mite, for example, the oscillator, r.f. amplifier, and modulator were all operated from a single 400-volt supply.

The switch necessary for such meter-switching must be of the non-shorting type, such as the Yaxley 1313L. 3-point, 3-circuit. This same type of meter switching can be extended to four, five or six plate circuits by using a switch capable of handling that many circuits. However, the limitation of a single power supply, insofar as a transmitter is concerned, generally limits it to three.

If more than one plate supply is used, a meter switching arrangement such as that shown in figure 2 could be used. In such a circuit, the milliammeter is grounded and cathode current is read in each circuit desired, such as the four separate ones shown in the diagram. It must be remembered, of course, that such a circuit (since it reads cathode currents) includes grid current readings as well as plate. However, plate potentials may be in the 2000- to 3000-volt range with this system with complete safety. The switch required must be of the shorting variety, and can be of any number of a variety of types readily available. The number of points and the number of switch sections are directly suggested by the number of circuits it is desired to read. Dotted lines in the diagram show where shunting resistors may be wired to add range to the milliammeter used.

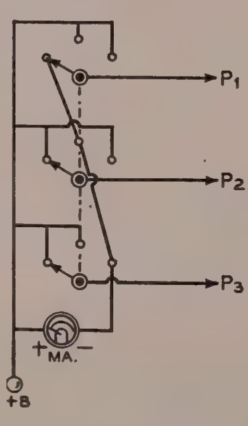


Figure 1

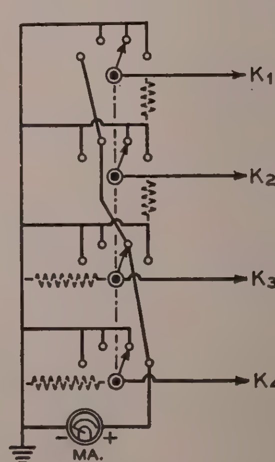


Figure 2

Illustrated in figure 3 is shown a popular system of using one meter to measure the current through several circuits. These may be grid circuit, plate circuits, etc. A small resistor of, say, 25 ohms is wired permanently in series with each circuit to be metered, and the meter may be thrown across any resistor by means of the selector switch. As the resistance of these metering resistors is high in proportion to that of the meter, the meter reading will not be affected, yet the resistance of these resistors is low enough that the circuit is not disturbed appreciably when the resistor is in the circuit.

A modification of this system permits two or more ranges for the meter. For instance, 50-ohm carbon resistors can be inserted in the grid circuits, and the meter will read actual current. Then, in series with the plate circuits can be placed meter shunts of such value as to give the desired full-scale meter deflection. Thus, a 25-ma. meter can be used as a 25-ma. meter to measure grid current, and as a 250-ma. meter to read plate current.

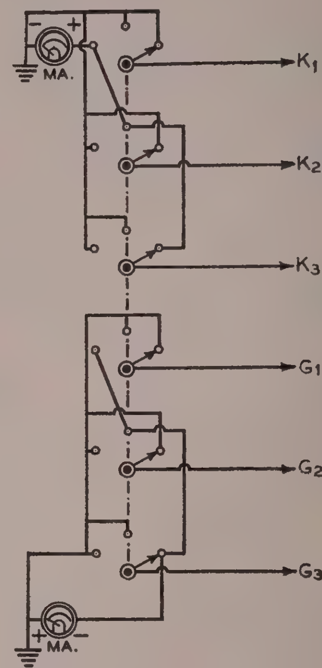


Figure 4

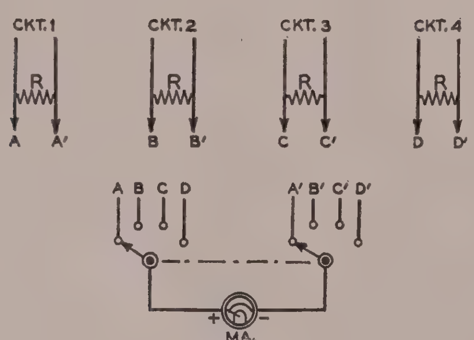


Figure 3

Figure 4 shows two meters being used in a circuit along the lines of the plate switching circuit of figure 1, and reading both cathode and plate currents on identical stages simultaneously.

A great many amateurs have utilized 0-1 milliammeters to good advantage in test sets, and these can be put to good use, if available, in measuring not only plate current but also plate voltage in an amateur transmitter by means of the meter-switching circuit shown in Figure 5. A multiplier resistor, its value calculated by Ohms law, is placed in the circuit as shown, and the shunt resistor is also placed as shown. Thus, this particular meter can be made to read, at a twist of the wrist, the plate voltage of a particular stage, and also the plate current flowing in such a stage. Figure 6 shows a further advancement along this line, where one such meter arrangement is made to include another circuit with proper shunt resistor to read grid current. Calculations of resistors can be made by Ohm's law, and the switch must be of the non-shorting type.

The meter-switching circuits described herein are not offered as an ultimate answer, but merely to encourage some thought along the line of switch circuits. Any of these circuits may be further developed to do an untold number of jobs, all at a great saving to the amateur. Needless to say, it would be wise to include a meter fuse at the meter connection in the event of a switch breakdown, though none has yet occurred in any of the author's equipment.

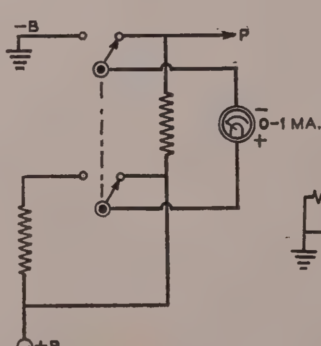


Figure 5

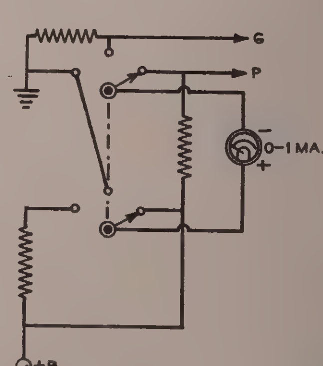


Figure 6


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# YARN of the MONTH

## GREEN CHEESE IN THE SUMMER

Major Hugh Crumpitt, U. S. Army Retired, glared across the bleak expanse of three back yards. He was staring at a newly-erected fifty-foot mast.

"Garrroumphoophh!" he exploded. "Another one of them! Blasted Hams! Perdition take the lot of 'em." His pudgy hands clasped and unclasped convulsively. "Well, I know how to take care of that breed." He retired into the house.

The Major was a typical retired old scullion. Five foot five, he usually sported a riding crop, a walrus moustache, and a horsey look. Now he was bellowing to Muggins, his valet, handyman, chauffeur, and janitor.

"Muggins." A pause. "Muuuugginnns!"

A withered, scrawny little man appeared on the scene. His bald head glistened like a brass railing.

"Yes, sir?"

"Go up into the attic and fetch me my elephant gun. You *know,* the big one with the silencer on it. Now hurry."

"Yes, sir." Muggins knew better than to argue when the Major's face was that ochre color. Once before he started an argument, the time the Major was running after the butcher with a large carving knife, and the Major nearly cut his nose off. (I mean Muggins' nose, not the butcher's.) So, Muggins merely said, "Yes, sir," and started up to the attic.

Three back-yards away, Walter N. Smetz, W3RGH, was whistling to himself quite a merry tune as he was hoisting the far end of his 160-meter zepp. For Walter, life was full of pleasant promises. He had just completed a kilowatt 160-meter 'phone, had moved into a location where he really could put up an *antenna,* and, to top it all, he had Phyllis Crumpitt. Phyllis was really a deal. She had class. So Walt was happy, and he kept on whistling. Perhaps if he had an inkling of the storm-clouds brewing, he would not have whistled. But, being a Ham, we know he would have kept on raising the antenna just the same.

Walt glanced at his wrist-watch. It was just 8:30. That gave him ample time to tune up the rig, get washed up, and go riding with the apple of his eye, his petunia, Phyllis Crumpitt.

At the same time, in the Major's domicile, Phyllis was also humming to herself. She was thinking practically the same thing as Walt, but in the other gender, of course. At last Walt lived in the same block as she. As yet, she had neglected to tell her papa, the Major.

A couple of hours later, Walt was still whistling and Phyllis was still humming; this time, both of them in Walt's car, which was whizzing down the highway like a demon. Suddenly Phyllis stopped. So did the car, because, as is usual in these cases, Walt ran out of gas.

"You know, Walt darling," chortled Phyllis, "I'm worried about Papa."

Walt knew nothing, and cared less, about Miss Crumpitt's recent ancestors. Therefore he said, in what he hoped was a properly sympathetic voice, "Yes, dear?"

"His rheumatism is getting worse and worse. Only this morning he had a salesman at the house who was showing him some kind of a big machine which he called a diathermy—why, what's the matter, Sugar?"

Walt was a little pale around the gills.

"Diathermy, eh?" He ran a finger around under his collar.

"Yes, and the salesman was explaining that the only drawback to it was that it created a lot of static and noise on the radio, especially on short waves. Dad was saying that he didn't

[*Continued on Page 90*]

By LEONARD J. SADOSKI, W3HRF

# *What's New . . . .*

# IN RADIO

## WATERPROOF CINAUDAGRAPH SPEAKERS

Originally designed for the U.S. Navy, the Cinaudagraph Mallard line of speakers, available in sizes from 3½" to 12", is entirely waterproof, and can be operated under water. They are of the permanent magnet type.

During tests of the new units it was found that they worked as well under water as in air, except that considerably more power was required to activate the unit. The cone action was the same in either medium, but the voice coil was able to withstand 300% more wattage when completely immersed. This was due to the increased load on the cone offered by the water, and to the cooling action of the water in dissipating any heat generated in the voice coil.

These speakers are manufactured by Cinaudagraph Speakers, Inc., 921 W. Van Buren Street, Chicago, Ill., and are intended for marine and out-of-door installations.

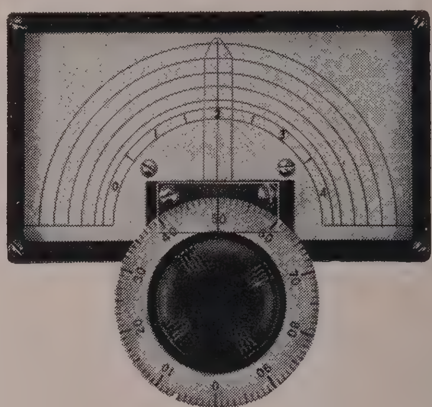
## NEW DECADE INDUCTANCE

Because of several requests received from customers, the New York Transformer Co., 480 Lexington Ave., New York City, has designed a new type decade inductance. This new unit is a precision laboratory device, valuable to the technician as an aid in setting up experimental filters, equalizers, tuned amplifiers, phasing networks, etc.

The NYT Co. Decade Inductance is available in decades from .001 henries per step to 10 henries. The Q is approximately 25, with a useful range of 50 to 20,000 cycles per second. It has an accuracy of plus or minus 5% with an operating level up to 30 db. These instruments may be had in either 2 or 3 decades in any of the inductance ranges desired.

## MIDGET INSULATED RESISTORS

In keeping with the trend towards still more compact radio components, Aerovox Corporation of New Bedford, Mass., has just announced smaller insulated molded carbon resistors. The new ½- and 1-watt units are considerably smaller than previous units bearing the same wattage ratings and type numbers. The size reduction is due to improvements in the resistance elements, and in no way reduces the load-handling properties of the units.



## NEW VERNIER DIAL

A precision-built gear-driven dial has just been announced by Bud Radio Inc. of Cleveland, Ohio. This dial is designed for use on instruments where extreme accuracy of calibration is essential.

This dial is driven with spring-loaded gears to insure freedom from backlash. It is calibrated in 500 divisions over the 180 degree scale. The dial is easily panel mounted, with the gear drive unit behind the panel and the dial scale on the front of the panel. This scale may be removed for calibration without removing the dial drive. Mounting area is 5¼" by 5¾". The gear ratio between the knob shaft and pointer shaft is 10 to 1. A friction clutch on the knob shaft prevents damage to the gears when maximum or minimum rotation is reached.

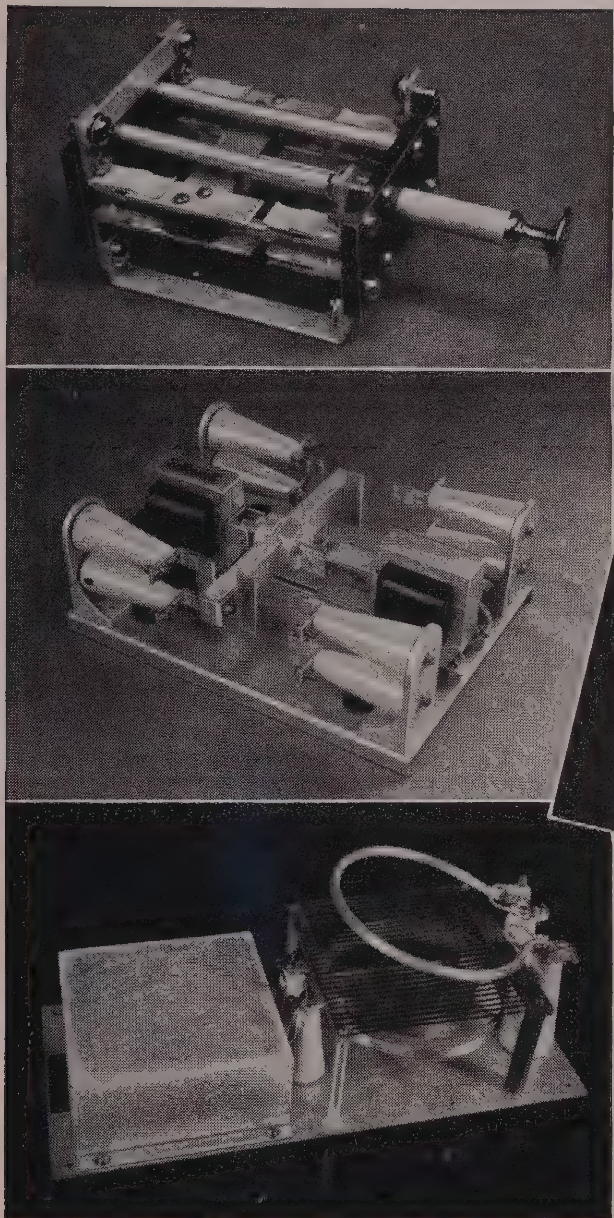
## 1942 HALLICRAFTERS "SKYRIDER 32"

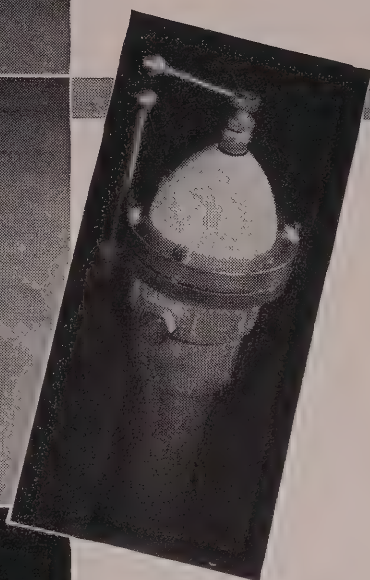
In addition to the usual communications receiver features, the Model SX-32 has two tuned r.f. stages, six degrees of selectivity (three with crystal filter), wide-angle illuminated "S" meter, six tuning ranges for most satisfactory L/C ratios and uniformly high sensitivity, temperature-compensated oscillator, bandspread

[*Continued on Page 68*]

# *Hard to Get*

## COMPONENTS FOR BROADCASTING STATIONS





Above is illustrated an R. F. Make-Before-Break Switch for inserting and removing a meter without breaking the circuit. The R. F. Contactor uses knife-type contacts and requires no holding current. The Isolation Transformer is used to feed sampling lines and for remote metering. Shown also is a terminal and safety gap for Johnson 2⅝ inch concentric line.

Much of Johnson's business consists of the design and manufacture of special components for specific applications. Johnson Engineers are thoroughly familiar with all phases of radio transmission and will be glad to assist you with your problems with no obligation to you. Write them today.

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## What's New

[*Continued from Page 66*]

dial directly calibrated for 80-, 40-, 20-, and 10-meter ham bands, antenna trimmer control on front panel, phono jack, a.c. line operation with optional choice of battery or external vibrapack operation through instantaneous change-over plug, etc.

The tuning range is from 500 kc. to 40 Mc. in six overlapping bands. All bands are fully calibrated on main dial, and the electrical bandspread system permits spread of any portion of the receiver's tuning range. Thirteen tubes are employed, including separate h.f. oscillator and mixer tubes, two tuned r.f. stages, two dual tuned i.f. stages, a.v.c. amplifier, automatic noise limiting, b.f.o., audio voltage amplifier, and push-pull 6V6 output.

Normally supplied with a steel cabinet, the chassis can be standard rack mounted. Complete in cabinet the receiver is 20½" long, 14½" deep, and 9½" high. The ventilated cabinet is finished in machine-tool gray wrinkle with stainless satin trim.

## NEW THORDARSON FILAMENT TRANSFORMER

Thordarson announces the addition of a new "19" Series filament transformer. This transformer, T-19F75, is especially recommended for use with the new RCA 816 rectifier tube. Characteristics of the tube make its application particularly suitable for amateur radio work, and Thordarson designed the T-19F75 to match it.

The T-19F75 is an open frame type with a 115 volt 50-60 cycle primary. Its secondary rating is 2½ volts @ 5 amps. c.t. The test voltage is 7500 volts r.m.s.

More complete information on this new transformer and other regular types is given in Catalog No. 400-F, available free from any distributor or direct from the factory: Thordarson Electric Mfg. Co., 500 W. Huron Street, Chicago, Illinois.

## CENTRALIZED SOUND SYSTEM INCLUDES F.M./A.M. TUNER

The new Hallicrafters Model RSC-2 is a unit intended for centralized radio systems in hotels, hospitals, and industrial plants. Because it provides both f.m. and a.m. broadcast reception it will offer special appeal to those institutions where high electrical noise levels have made ordinary radio reception unsatisfactory. In addition, the f.m. feature provides the finer quality so desirable for distribution in the dining rooms or other public rooms.

The RSC-2 includes three units—an f.m./a.m. tuner, a high fidelity 25-watt amplifier and a monitor speaker, all inclosed in a single rack of the table-mounting type. The tuner provides a.m. reception throughout the range of 540 to 1650 kc., and f.m. in the range of 40 to 51 Mc. In addition, the amplifier provides microphone and phono inputs, thus making these additional types of service available for distribution over the centralized loudspeaker or headphone networks. Wide operating flexibility is afforded by separate bass and treble equalization controls, separate control of volume from each input source, and provision for mixing and fading these sources.

An outstanding feature of this equipment is its tone quality. The frequency response of the amplifier alone is flat within plus or minus 1½ db from 30 to 20,000 cycles per second. The response of the tuner alone for f.m. reception varies less than 1 db from 30 to about 7,000 c.p.s., is down only 1.8 db at 10,000 and 4 db at 15,000 c.p.s.

For existing installations where it is desired to modernize equipment, both the S-31 f.m./a.m. tuner and the S-31A amplifier employed in this combination are available separately.

## NEW JENSEN "SPEECH-MASTER" REPRODUCER

A new type AP "Speech-Master" Reproducer, for highly effective reproduction of speech, has recently been announced by Jensen Radio Manufacturing Company, 6601 So. Laramie Ave., Chicago. Two models are available—the AP-10 for desk or wall mounting, and the AP-11 for panel mounting. A special PM unit, employing the Jensen Peri-Dynamic principle, provides the special characteristic necessary for maximum intelligibility on speech. Power rating is 5 watts maximum —unusually high for such a small reproducer.

[*Continued on Page 76*]

# YOUR *New* SX-32 IS READY *Where shall I ship it?*

***HERE IT IS—the new Hallicrafter SX-32—the receiver I know you'll want to have for your rig!***

**This latest addition to the famous Hallicrafter line is the finest, most up-to-date receiver in its price field. Where else but in the new Hallicrafter SX-32 can you find such expensive features at a moderate price? . . . Thirteen tubes. A tuning range of 500 kc. to 40 mc. Two stages of preselection. AVC-BFD switch. Micrometer scale tuning inertia controlled. Crystal phasing. Push-pull high fidelity, audio output. 6 step wide range variable selectivity. And many other highly desirable features.**

**Why not trade that outmoded receiver in on this up-to-the-minute Hallicrafter SX-32? It's worth a liberal trade-in allowance from me, so drop me a line here at Butler and get my free estimate! My rock-bottom 6% terms (financed by me to save you money) PLUS my liberal trade-in allowance makes any receiver in my stock—the world's largest . . . within your easy reach.**

***Drop me a line today, won't you!***

*Bob Henry*

**HENRY RADIO SHOP** — **W9ARA** — BUTLER MISSOURI

# POSTSCRIPTS... *and Announcements*

### 1941 Midwest Division Convention

The 1941 Midwest Division Convention will be held at the Hotel Muehlebach, Kansas City, Missouri, on October 11th and 12th. This year the convention is being held under the auspices of the Heart of America Radio Club of Kansas City, Mo. Information concerning the event may be obtained by writing to the ARRL Midwest Division Convention Committee, P.O. Box 7092, Kansas City, Missouri.

### Steve Paull, KD4GYM

A letter from Steve Paull in regard to his Swan Island story in the July issue states:

"Only one little 'tragedy' in regard to the article. The picture which was supposed to be me isn't at all. That is a picture of Harold Crutcher, 'Crutch.' I guess you got the negatives turned around, or something. Anyway you printed the best looking guy. Perhaps in the next issue you might include something to the effect that KD4GYM is not nearly as handsome as the July issue makes the gentle reader think."

We're sorry about the error, but maybe the above correction will make everything all right.

### Copeland Converter

Through an error in the production department, the values of the resistors for Bill Copeland's u.h.f. converter were omitted from the diagram caption appearing on page 18 of the June issue of RADIO. We have received a large number of inquiries for these values, so they are being published herewith:

| | |
|---|---|
| $R_1$—1.0 megohm | $R_7$—250 ohms |
| $R_2$—1000 ohms | $R_8$—10,000 ohms |
| $R_3$—100,000 ohms | $R_9$—3000 ohms |
| $R_4$—2000 ohms | $R_{10}$—5000 ohms |
| $R_5$—40,000 ohms | $R_{11}$—30,000 ohms |
| $R_6$—50,000 ohms | |

Also, there was an error in the diagram; the screen by-pass condenser $C_8$ was placed on the wrong side of the screen dropping resistor $R_5$.

### Read Keying Monitor

Cy Read notified us to the effect that we made an error in regard to the diagram caption for his keying monitor which appeared on page 56 of the June issue of RADIO. The values for $C_1$ and $C_2$ were reversed; $C_1$ should be 0.1 $\mu$fd., and $C_2$ should be 0.002 $\mu$fd.

### Attention All "Ham" Dentists

All dentists who are amateurs and plan to attend the eighty-third annual convention at Houston, Texas, October 26 to 31 and would like to meet some of the gang at a dinner, please get in touch with Dr. A. D. Uhls, W9RGV, 258 Plaza Bank Building, Kansas City, Missouri.

#### Boston Hamfest

"The New England Division Convention and 8th Annual Boston Hamfest, sponsored by the Eastern Massachusetts Amateur Radio Association and the South Shore Amateur Radio Club, will be held at the Hotel Bradford, Boston, Massachusetts, on October 18. Registration fee will be $1.00 and banquet $2.00, or a combined ticket for $2.50. The banquet will be limited to 400; so get your reservations in early.

"An exhibit of emergency equipment will be held and all amateurs are invited to submit entries. Prizes will be awarded. Meetings for the ORS—AARS—AEC—UHF—OPS and other groups will be held, and several technical talks will be given. A 2½ meter hidden transmitter hunt will also be held.

"For additional information write to Convention Chairman Harry A. Gardner W1EHT at 25 Hillside Ave., Stoneham, or to Convention Secretary Fred C. Hall W1MZE at 97 Cambridge St., Winchester, Mass. Bob Williams W1JOX is in charge of tickets, and can be addressed at 105 Harvard St., Newtonville, Mass."

•

### *Progress of NBC Commercial Television*

Planning for commercial television as authorized by the FCC in its rules of May, 1941, the National Broadcasting system has made application to the FCC for a commercial television license for a station in Washington, D.C. In addition, they have agreed to alter all RCA television receivers in the New York area to conform to the new standards at no cost to the owners.

The New York station of NBC, W2XBS, located in the Empire State Building, is already operating on a commercial basis. The projected Washington station will be ready for testing on about the first of November, this year, and will be ready for commercial operation on March 1, 1942. A site has also been selected for an NBC television station in Philadelphia. The Philadelphia station is scheduled for commercial operation on July 1, 1942, but it is mentioned that this date will be subject to progress on the New York and Washington sites, and also subject to availability of equipment.

# NEW BOOKS *and trade literature*

### Third Edition Radio Engineering Handbook

RADIO ENGINEERING HANDBOOK, *edited by Keith Henney*. Published by McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N.Y. 945 pages, 4½" x 7", 836 illustrations, over 100 tables. Price of flexible fabrikoid edition, $5.00 in U.S.A.

The new third edition has been written by 23 experts, with Keith Henney as editor-in-chief. It presents much-needed reference material on all aspects of radio engineering in concise, easy-to-get-at form. Emphasis is on design data, presented in a profusion of tables, charts, equations, formulas, and diagrams. It contains new data on crystal control circuits, ultra-high frequency apparatus, modulation systems, audio-frequency transformer design, vibrator power supply, long-line oscillators, etc.—rewritten sections on aircraft radio, television, detection, loud speakers, facsimile, etc. Each of the chapters has been written by an expert in the particular field with which the chapter deals.

### New Reference Book on Aircraft and Manufacturers

AEROSPHERE, 1941. *Edited by Glenn D. Angle*. Published by Aircraft Publications, 370 Lexington Avenue, New York, N.Y. 948 pages, 8½" by 11½", 933 illustrations and photographs. Price of clothbound edition in U.S.A., $10.00 plus transportation.

This large and complete book gives extensive information about the entire world's aircraft and engines and all related activity. The nearly 1000 oversize pages are packed with the latest information on air developments of the U.S.A., Great Britain, Germany, and 23 other nations. Every phase of international aviation is exhaustively treated, indexed, and cross-indexed.

The section devoted to planes takes up 320 pages, with 533 drawings and photographs. 160 pages and 269 photographs are devoted to the present and developmental engines of 118 world-wide manufacturers. In the section devoted to statistics, facts and figures are given on passenger-miles flown, speed and endurance records, accidents, engine production from all over the world. Another valuable section is the Buyer's Guide which gives up-to-date listings of names and addresses, principal personnel and products made, of all firms engaged in every phase of aeronautics throughout the world. American manufacturers are listed geographically. This section should be valuable to those engaged in the manufacture of aircraft radio equipment.

### New Transmitting Tube Guide

RCA GUIDE FOR TRANSMITTING TUBES. Published by Commercial Engineering Section, RCA Manufacturing Co., Inc., Harrison, N.J. 72 pages, 69 tubes, 5 transmitters, 150 circuits. Price, 25 cents.

This engineering and amateur guidebook on transmitting tubes is available through RCA Tube and Equipment Distributors throughout the country. It contains comprehensive data on 69 air-cooled transmitting tubes, including the new types 815, 816, 8000, 8001, 8005, and the midget tubes 9001, 9002, and 9003. Complete data, supplemented by circuits, show how these tubes may be used to the best advantage. The book contains 150 circuits and illustrations, and is twice the size of last year's edition.

An important feature of the new guide is found in the transmitter designs, which are shown in great detail. They were designed, constructed, and tested specifically for inclusion in the book. All the equipment described represents a wide range of application and meets modern demands for ready transmitter simplicity coupled with efficiency, economy, and flexibility.

### New Howard Amateur Folder

The Howard Radio Company of Chicago announces the new edition of their amateur Folder No. 109, containing the complete line of Howard communication receivers, and showing latest prices. Accessories and recording discs especially suitable for amateur requirements are also included. The booklet is available without charge from distributors, or direct from Howard Radio Company, 1735 Belmont Avenue, Chicago, Ill.

### New Sprague Koolohm Catalog

A new Sprague Koolohm Resistor Catalog just issued includes many new types plus detailed information on this type of resistor construction. A copy of the new catalog will gladly be sent upon request to The Sprague Specialties Co., Resistor Division, North Adams, Mass.

### New Bud Catalog

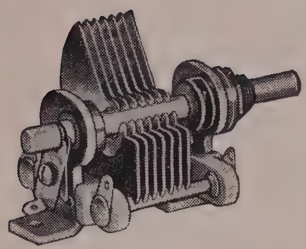
Bud Radio, Inc., of Cleveland, Ohio, has recently issued a new General Catalog No. 241. It describes their complete line, and contains a numerical list price section. On the front and back inside covers are given several tables of information which is likely to be of use to most radio men. The 40-page pamphlet is also thumb-indexed for ready reference. Copies may be obtained by writing Bud Radio, Inc., Cleveland, Ohio.

### J. W. Miller Catalog

The J. W. Miller Company, of Los Angeles, has just released a new 46-page catalog covering their line of coils, condensers, kits, cabinets, chassis, dials, and other radio specialties. A number of circuit diagrams are included in the back of the catalog. Copies may be obtained from the main office at 5917 South Main St., Los Angeles, Calif.

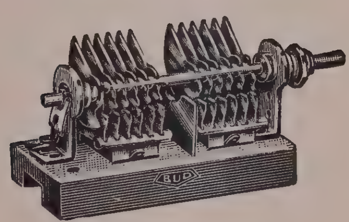
"Henry is trying out his new portable."

# *Use* BUD CONDENSERS *for "peak" performance*



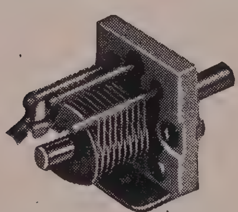
**DOUBLE BEARING MIDGETS**

| Cat. No. | Cap. Mmfd. | Air-Gap | Net Price |
|---|---|---|---|
| MC-900 | 20 | .024″ | $0.84 |
| MC-903 | 50 | .024″ | 0.96 |
| MC-905 | 100 | .024″ | 1.35 |
| MC-907 | 150 | .024″ | 1.59 |
| MC-908 | 200 | .024″ | 1.65 |
| MC-909 | 250 | .024″ | 1.80 |
| MC-910 | 325 | .024″ | 2.10 |
| MC-565 | 15 | .060″ | 1.08 |
| MC-941 | 100 | .060″ | 2.10 |
| MC-966 | 50 | .095″ | 1.80 |



**DUAL MIDGETS**

| Cat. No. | Cap. Mmfd. per. sec. | Air-Gap | Net Price |
|---|---|---|---|
| MC-911 | 100 | .024″ | $2.10 |
| MC-912 | 140 | .024″ | 2.40 |
| MC-913 | 35 | .060″ | 2.10 |
| MC-329 | 35 | .095″ | 2.55 |



**TINY MITES**

| Cat. No. | Cap. Mmfd. | Air-Gap | Net Price |
|---|---|---|---|
| LC-1640 | 8 | .017″ | $0.63 |
| LC-1641 | 15 | .017″ | 0.69 |
| LC-1642 | 25 | .017″ | 0.81 |
| LC-1643 | 35 | .017″ | 0.90 |
| LC-1644 | 50 | .017″ | 0.96 |
| LC-1645 | 75 | .017″ | 1.08 |
| LC-1646 | 100 | .017″ | 1.14 |

- You can rely on BUD Condensers for efficient, dependable performance. Their superior design and rugged construction are your assurance of permanently satisfactory service.

- BUD Midget Condensers are universally used in receivers, low and medium power transmitters, monitors, frequency meters, etc. They feature soldered brass rotor and stator assemblies, accurately fitted bearings and Alsimag 196 insulation.

- BUD Junior Transmitting Condensers are the first choice of those who desire compactness, efficiency and economy. Made in single and dual units in a large variety of sizes and air-gaps.

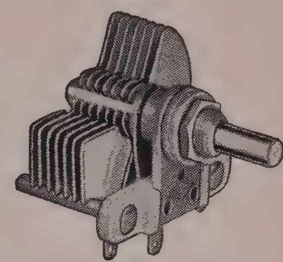
- BUD Tiny Mites are preferred in U.H.F. and portable equipment or wherever compact design and light weight are essential.

- BUD Neutralizing Condensers feature vibration-free construction and two-way mounting provision. Three types are made to accommodate all usual neutralizing requirements.

• • •

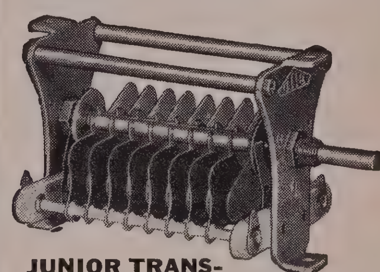
Only a few of the many types of BUD Condensers are shown on this page. Consult your jobber for complete information or write for your copy of the latest BUD Catalog.

*Prices subject to change without notice.*



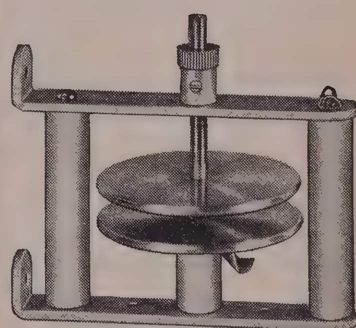
**SINGLE BEARING MIDGETS**

| Cat. No. | Cap. Mmfd. | Air-Gap | Net Price |
|---|---|---|---|
| MC-1870 | 15 | .024″ | $0.60 |
| MC-1872 | 35 | .024″ | 0.60 |
| MC-1873 | 50 | .024″ | 0.66 |
| MC-1875 | 100 | .024″ | 0.84 |
| MC-1876 | 140 | .024″ | 0.90 |
| MC-1880 | 35 | .060″ | 0.84 |



**JUNIOR TRANSMITTING CONDENSERS**

| Cat. No. | Cap. Mmfd. | Air-Gap | Net Price |
|---|---|---|---|
| JC-1525 | 50 | .051″ | $1.83 |
| JC-1526 | 100 | .051″ | 1.98 |
| JC-1528 | 250 | .051″ | 2.91 |
| JC-1532 | 55 | .078″ | 2.10 |
| JC-1534 | 110 | .078″ | 2.55 |
| JC-1535 | 150 | .078″ | 3.06 |
| JC-1537 | 245 | .078″ | 4.53 |
| JC-1541 | 80 | .144″ | 2.91 |
| JC-1547 | 100 | .175″ | 4.35 |



**NEUTRALIZING CONDENSERS**

| Cat. No. | For Tube Types | Net Price |
|---|---|---|
| NC-1000 | 35T, TZ-40, 812, etc. | $1.80 |
| NC-1001 | 100TH, HK-254, T125, etc. | 2.70 |
| NC-1002 | 211, 203, T-814, etc. | 3.75 |

BUD   **BUD RADIO, INC.**   BUD
CLEVELAND, OHIO

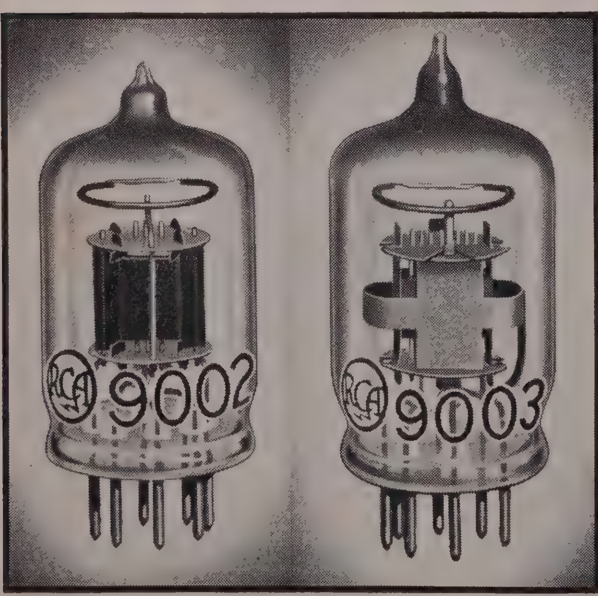
# NEW TUBES

## New U.H.F. Midget Tubes

RCA has announced three new tubes designed for ultra-high-frequency receiving and oscillator applications: types 9001, 9002, and 9003. These tubes use the same bulb and base as the miniature receiving tubes, and element structures similar to those of the 6.3 volt acorn tubes. Two cathode leads are used in each of the tubes to permit completion of the plate and screen r.f. circuits in a manner such as to reduce to a minimum the circuit inductance common to the grid circuit. The 9002 also has two plate leads.

The electrical characteristics of the 9001, 9002, and 9003 correspond to those of the 954, 955, and 956, respectively. The 9001 is a sharp cut-off pentode, which can be used advantageously as an r.f. amplifier or mixer where a remote cut-off tube such as the 9003 is not necessary, or where the available a.v.c. voltage is small. In such cases the low current requirements of the 9001 give an improved signal-to-noise ratio. The triode 9002 can be used as an oscillator in superheterodyne receivers at frequencies up to 500 Mc. The 9003 is a super-control pentode intended for r.f. or i.f. amplifier and mixer functions.

The ratings of these tubes are as follows:




### 9001

**Detector Amplifier Pentode**

| | |
|---|---|
| Heater Voltage (a.c. or d.c.) | 6.3 Volts |
| Heater Current | 0.15 Amp. |
| Direct Interelectrode Capacitances: | |
| Grid-Plate | 0.01 Max. $\mu\mu$fd. |
| Input | 3.6 $\mu\mu$fd. |
| Output | 3.0 $\mu\mu$fd. |

**MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS**

| | | |
|---|---|---|
| Plate Voltage | | 250 Max. Volts |
| Screen Voltage | | 100 Max. Volts |
| Grid Voltage | | –3 Min. Volts |
| Typical operation as Class $A_1$ Amplifier: | | |
| Plate Voltage | 90 | 250 Volts |
| Screen Voltage | 90 | 100 Volts |
| Grid Voltage | –3 | –3 Volts |
| Plate Resistance (Approx.) | 1.0 | Greater than 1 Megohm |
| Transconductance | 1100 | 1400 $\mu$mhos |
| Plate Current | 1.2 | 2.0 Ma. |
| Screen Current | 0.5 | 0.7 Ma. |
| Typical Operation as Mixer in Superheterodyne Circuits: | | |
| Plate Voltage | 100 | 250 Volts |
| Screen Voltage | 100 | 100 Volts |
| Grid Voltage (Approx.)* | –5 | –5 Volts |
| Conv. Transconductance (Approx.) | – | 550 $\mu$mhos |

**The grid bias shown is minimum for an oscillator peak voltage of 4 volts. These values are optimum.*

### 9002

**Detector Amplifier Triode**

| | |
|---|---|
| Heater Voltage (a.c. or d.c.) | 6.3 Volts |
| Heater Current | 0.15 Amp. |
| Direct Interelectrode Capacitances: | |
| Grid-Plate | 1.4 $\mu\mu$fd. |
| Grid-Cathode | 1.2 $\mu\mu$fd. |
| Plate-Cathode | 1.1 $\mu\mu$fd. |

**MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS**

| | | |
|---|---|---|
| Plate Voltage | | 250 Max. Volts |
| Typical Operation as Class $A_1$ Amplifier: | | |
| Plate Voltage | 90 | 250 Volts |

[*Continued on Page* 77]

## "EVER SINCE HE GOT THEM NEW G-E CAPACITORS HE WON'T LET NOBODY NEAR THE SHACK."

Filter troubles take a beating when you install Pyranol* capacitors—a beating that lasts for years and years.

And here's some more good dope on Pyranols:

- ★ Continuous operation at 10% above rating
- ★ Long life, for low cost per service-year
- ★ Small size—means easy portability
- ★ Upright or inverted mounting
- ★ Round or rectangular cases
- ★ More than 50 ratings to choose from
- ★ More than a million units in service
- ★ Hermetically sealed for permanence

*Reg. U.S. Pat. Off.

**NEXT TIME YOU NEED TUBES—**

**GET G.E.'S AND MEASURE THE IMPROVEMENT**

### FREE for your shack wall!

☐ **ENLARGEMENT OF THIS CARTOON,** *drawn by Paul Webb of ESQUIRE fame, reproduced on tapestry-finish paper.*

*Also*

*☐GEA-3315B on G-E Transmitting Tubes*
*☐GEA-2021B on G-E Pyranol Capacitors*

*General Electric, Section R407-10, Schenectady, N.Y.*

*Please send me free the items checked.*

*Name*..............................

*Address*..............................

*City*.............................. *State*..............

407-10-6900

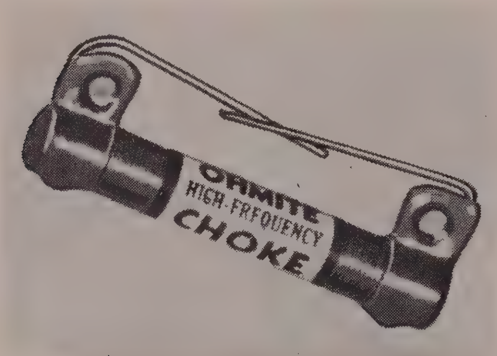
**GENERAL ELECTRIC**

## What's New

[*Continued from Page 68*]

### 2½-METER R.F. PLATE CHOKE

A new 2½-meter band r.f. plate choke Z-O has been added to the series of radio frequency plate chokes made by the Ohmite Manufacturing Company, Chicago. It is single layer wound on a low power factor steatite tube, and the winding is covered with a moisture-resisting insulating material. Because of the single layer winding, the voltage differential between adjacent turns is low, and the possibility of breakdowns between turns is eliminated.




The new Z-O r.f. plate choke, because of its small size is especially applicable to transceivers, 2½-meter mobile transmitters, and therapeutic and diathermy equipment. Mounting is by means of the wire leads. Other sizes available are for the 5-, 10-, 20-, 40-, 80-, and 160-meter bands. For further information, write to the Ohmite Manufacturing Company, 4835 Flournoy Street, Chicago, U.S.A.

### 110-VOLT A.C. LIGHT AND POWER PLANTS

The Kato Engineering Company, Mankato, Minnesota, has announced a new line of light and power plants. Models are available with capacities of 600 watts (14A), 1000 watts (26A), 1500 watts (28A), and 2000 watts (30A).

The generators are of the self-excited, single phase type, generating 110-volts, 60-cycle a.c. at 1800 r.p.m. Double sealed ball bearings are used, and the unit is bolted directly to the engine crankcase. D.c. at 12 or 32 volts may be drawn from the d.c. terminals when the plant isn't carrying full a.c. load. Both a.c. and d.c. brushes are easily accessible. The unit is filtered and shielded for radio operation. The voltage regulation is 8%.

The engine is a Briggs & Stratton 4-cycle, single-cylinder, air-cooled type with a float feed adjustable carburetor. An adjustable mechanical type, fully enclosed governor runs in oil. An oil-bath air cleaner is used. The gasoline tank is of one gallon capacity, mounted overhead. Lubrication is of the pump and splash type.

These plants are available with remote control or full automatic control.

### NEW ECHOPHONE RECEIVER

The Echophone "Commercial" Model EC-2, newest product of Echophone Radio Co., 201 East 26th St., Chicago, is designed to meet the exacting requirements of the amateur, and is equally well suited to the needs of the short-wave fan.

The EC-2 operates from either a.c. or d.c. lines and utilizes eight tubes to cover the continuous range from .55 to 30 megacycles. The receiver is housed in a gray-crackle cabinet of metal, the chassis being suspended therein on live rubber for required electrical isolation when operating from d.c. lines. A 5-inch pm speaker is mounted inside the cabinet top.

Some of its more important features include: A preselector stage on all bands, separate electrical band-spreading of any part of the main tuning range, automatic noise limiter, beat-frequency oscillator, loudspeaker-headphone switch, a.v.c. applied to r.f., mixer and i.f. tubes, standby switch, connections for either "L" or doublet antennas.

The oversize dial simplifies tuning by providing separate pointers and scales for main tuning and band-spreading. The main tuning scales are calibrated in megacycles. Five band-spread scales include the conventional 0-100 calibration and individual frequency calibrations for the 10-, 20-, 40-, and 80-meter amateur bands.

### KOOLOHMS DESIGNED FOR MAKING UP TAPPED RESISTOR SECTIONS

Type VD Koolohm resistors provide a handy, economical answer to the problem of making up tapped resistors with any number of 10- or 15-watt sections of any required resistance values.

The Koolohms are supplied in compact 10- or 15-watt sections equipped with ball and recess interlock feature. This prevents turning and automatically connects the units electric-

[*Continued on Page 98*]

## An Inexpensive Electronic Bug

[*Continued from Page 38*]

two knobs to change speed, but it was not as much bother as it was feared it might be. When changing speed, the controls should be set at the approximate speed desired and the final adjustment made with one hand while sending with the other. If there is a tendency to send extra dots, the dots should be slowed down, and if there is a tendency to send an extra piece of a dash occasionally, the dots should be speeded up. When you get the hang of it, sending good code becomes effortless and almost automatic—so they tell me.

A list of parts is included for those who may wish to build a unit similar to that in the photographs. The total cost of the unit pictured was about $5, which compares favorably with the cost of a mechanical bug which makes dots only.

## New Tubes

[*Continued from Page 74*]

| | | | |
|---|---|---|---|
| Grid Voltage | –2.5 | –7 | Volts |
| Amplification Factor | 25 | 25 | |
| Plate Resistance | 14700 | 11400 | Ohms |
| Transconductance | 1700 | 2200 | µmhos |
| Plate Current | 2.5 | 6.3 | Ma. |

### 9003

**Super-Control Amplifier Pentode**

| | |
|---|---|
| Heater Voltage (a.c. or d.c.) | 6.3 Volts |
| Heater Current | 0.15 Amp. |
| Direct Interelectrode Capacitances: | |
| Grid-Plate | 0.01 Max. µµfd. |
| Input | 3.4 µµfd. |
| Output | 3.0 µµfd. |

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

| | |
|---|---|
| Plate Voltage | 250 Max. Volts |
| Screen Voltage | 100 Max. Volts |
| Grid Voltage | –3 Min. Volts |
| Typical Operation as Class $A_1$ Amplifier: | |
| Plate Voltage | 250 Volts |
| Screen Voltage | 100 Volts |
| Grid Voltage | –3 Volts |
| Plate Resistance (Approx.) | 0.7 Megohm |
| Transconductance | 1800 µmhos |
| Transconductance at –45 volts bias | 2 µmhos |
| Plate Current | 6.7 Ma. |
| Screen Current | 2.7 Ma. |

Typical Operation as Mixer in Superheterodyne Circuits:

| | | | |
|---|---|---|---|
| Plate Voltage | 100 | 250 | Volts |
| Screen Voltage | 100 | 100 | Volts |
| Grid Voltage (Approx.)** | –10 | –10 | Volts |
| Conv. Transconductance (Approx.) | – | 600 | µmhos |

*****The grid bias shown is minimum for an oscillator peak voltage of 9 volts. These values are optimum.*

## Hytron "Super Bantam" Tubes

The Hytron Corporation has brought out two new filament type pentodes of very low drain. Both use a "V" type high tensile strength alloy filament to afford maximum life and minimum microphonism. The tubes are supplied with 1½″ tinned flexible leads for direct electrical connection of the tube elements. For testing purposes an octal test base is supplied. The HY245 is intended for use as a high gain voltage amplifier in applications where very small size and low drain are important. The HY255X is intended to be used as a power output amplifier in similar cases. It has high power sensitivity. The tube dimensions are: 1.26″ long and 0.453″ in diameter.

### HY245

#### STATIC CHARACTERISTICS

| | |
|---|---|
| Filament Voltage | 1.25 Volts d.c. |
| Filament Current | .032 Amp. approx. |
| Plate Voltage | 45 Volts max. |
| Screen Voltage $G_2$ | 45 Volts max. |
| Grid Bias | 0 Volts |
| Plate Current | 0.4 Ma. approx. |
| Screen Current | 0.2 Ma. approx. |
| Mutual Conductance | 375 $\mu$mhos approx. |
| Plate Resistance | 1.0 Megohm approx. |

Typical Operation as Class A Amplifier:

**Resistance Coupled**

| | | |
|---|---|---|
| Plate Supply Voltage | 30 | 45 Volts |
| Screen Supply Voltage | 30 | 45 Volts |
| Grid Bias | 0 | 0 Volts |
| Plate Load | 1 | 1 Megohm |
| Screen Dropping Resistor | 3 | 2 Megohms |
| Grid Leak Resistor | 5 | 5 Megohms |

**Impedance Coupled**

| | | |
|---|---|---|
| Plate Supply Voltage | 30 | 45 Volts |
| Screen Supply Voltage | 30 | 45 Volts |
| Grid Bias | 0 | 0 Volts |
| Plate Load | 300 | 200 Henrys |
| Screen Dropping Resistor | 2 | 1 Megohm |
| Grid Leak Resistor | 5 | 5 Megohms |

### HY255X

#### STATIC CHARACTERISTICS

| | |
|---|---|
| Filament Voltage | 1.25 Volts d.c. |
| Filament Current | .040 Amp. approx. |
| Plate Voltage | 45 Volts max. |
| Screen Voltage $G_2$ | 45 Volts max. |
| Grid Bias | −1.5 Volts |
| Plate Current | 1.6 Ma. approx. |
| Screen Current | 0.60 Ma. approx. |
| Mutual Conductance | 550 $\mu$mhos approx. |

Typical Operation as Class A Amplifier:

| | | |
|---|---|---|
| Plate Voltage | 30 | 45 Volts |
| Screen Voltage | 30 | 45 Volts |
| Grid Bias | 0 | −1.5 Volts |
| Load Impedance | 0.04 | 0.025 Megohms |
| Grid Leak Resistor | 5 | 5 Megohms |
| Plate Current | 1.0 | 1.60 Ma. approx. |
| Screen Current | .30 | .60 Ma. approx. |
| Power Output | 10 | 18 Mw. approx. |
| Total Harmonic Distortion | 15 | 12% approx. |

## V.F.O. Design Considerations

[*Continued from Page 41*]

output is sufficient to drive a 6L6 or 807 to nearly full output.

### Mechanical Considerations

Needless to say, the v.f.o. unit—and particularly the oscillator portion—should be sturdily constructed. A heavy chassis and cabinet are indicated. Unfortunately the small cabinets generally offered are not sufficiently sturdy, but as a cast aluminum box is out of the question, something falling short of the ideal ordinarily will have to suffice.

The tuning condenser should operate smoothly, have snug, double bearings, and preferably be double spaced. The plates should be sufficiently heavy as to be non-microphonic. It should be mounted only with heavy brackets or husky insulators when it cannot be screwed directly to the chassis.

The tuning dial should be the best one can afford, as nothing is so disconcerting as a v.f.o. with a dial that leaves things to be desired. A flexible coupling should not be used unless absolutely necessary, as each flexible coupling will contribute a very small amount of backlash. If you don't believe it, just hook a dozen in series and see what happens.

The v.f.o. unit always should be set on a rubber pad. Perhaps the highest compliment one can pay to the mechanical ruggedness of a v.f.o. is that it "doesn't even need to be set on a rubber pad." However, the author has yet to see a v.f.o. which, without a pad, is perfectly immune to a heavy knock on the operating table. A pad can be purchased for as little as 25 cents, and no matter how good the unit is without a pad, it will be still better when "floating power" is employed.

### Ventilation

After one has designed the v.f.o. so as to minimize the generation of heat inside the cabinet, the next thing to consider is the removal of this heat as effectively as possible. Bear in mind that the air will enter the lower ventilating holes and leave by the upper ones. Therefore the holes should be so arranged that the convection currents in the cabinet carry the heat *away* from the oscillator components. The ventilation advantageously can be so arranged that the cool air entering the cabinet passes over the oscillator section before reaching the components responsible for most of the heat. This will

[*Continued on Page 79*]

## A 5- and 10-Meter Converter

[*Continued from Page 33*]

A wire is soldered to the hot side of the oscillator coil and twisted around the lead going from the r.f. plate coil to its tuning condenser, to neutralize the space charge effect in the 7Q7. Neutralization is done at the high-frequency end of the 5-meter band, and the capacity should be adjusted to give maximum sensitivity. Two turns around the r.f. stage lead will usually be the correct capacity. Once it is adjusted properly it need not be changed.

One version of this converter had hand capacity, but this was eliminated by connecting a .05-μfd. condenser from each of the 110-volt a.c. leads to the chassis.

### Operation of the Converter

This converter will receive every signal on the 10-meter band that can be heard on a DM-36 and RME-70 combination. Comparisons on the 5-meter band were impossible, as we lack a beam antenna for that band. The converter has been used for some time on a Philco model 66, which is a 6-tube b.c.l. set. This combination has filled our needs for both 5- and 10-meter reception. Using the converter with a well-designed ham receiver would probably give results that were all that could be desired.

No trouble was experienced with oscillations or birdies other than the harmonics of the main receiver's oscillator, and this was cured by shielding the latter.

The antenna input is designed for a doublet or beam, but a regular Hertz may be used by grounding one of the antenna posts to the converter chassis. Some of the stronger signals will block the b.c.l. or ham receiver, so it is recommended that a 20,000-ohm potentiometer be connected in the cathode of the 7V7.

## V.F.O. Design Considerations

[*Continued from Page 78*]

minimize the effects of heat transmitted to the oscillator components via the chassis.

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●

W1LJV lives on Halloween Blvd.

## The Open Forum

Arlington, Virginia

Sirs:

. . . Why, in the name of Pan-American unity; we, Americans all; and the thousand and one other "saws" being so glibly bruited over this land of ours in the name of inter-Americanism . . . why can't we amateurs have reissued to us the privilege of radio communication with the Central and South American "free" countries? After all, if we "old faithful" fourteen and twenty-eight Mc. adherents could expend our DX proclivities in contacting, say, LU, PY, CX, etc., then the almost irresistible appeal of those twenty-or-so D boys would not be so hard to submerge! This is not a particular "selfish" plea, since I have worked and received cards from all these countries—including Galapagos and Falkland Islands. . . .

WILLARD F. HUNTON, W3AG.

### Five-Meter Summer DX

[*Continued from Page 54*] .

band open four hours starting at nine in the morning, in which he hooked W8QQS LZN MYZ W9DYH IFW USI ZHB CJS DWU YLV YKX USI. W5DXW in Texarkana worked W8LZN (is this the same as W8LZM reported by W9ZJB?) QQS W9ZQC and heard a W6 working a W9, W9YLV working W4FKN, and W9CJS. W6QAP raised W9USI ZQC CJS YKX in the morning opening, with very loud signals from YKX until two o'clock. Then he got W7CIL in mid-afternoon, his signals lasting for an hour and a half. W6OVK got on the air in the afternoon for several contacts with W7CIL. W6SLO also worked W9YKX who had an R9 plus signal. W8RUE in Pennsylvania seemed to have a private band all of his own, hearing W4EDD FLH DXP, but W9AQQ cut in on his W4's and raised the three of them and also W5HYT. W9WWH worked W5HYT and heard W4DXP EDD. W9YKX in Iowa did well enough, with the band open to W2-3-5-6 for him, though he missed W4. Altogether, June 24 was not such a bad day.

*June 25.* Fewer reports were received for this day, but it was a good one for two hours from noon at W5AJG/JKM. The volume was so high that Leroy drove around the corner to get out of his wife's QRM and he worked his own station from there. In the meantime, his wife got W8LZN QQS RKE W9CBJ BDL AQQ ZHL ANH ZHB. Again that evening AJG got in more than three hours of dx, hooking W2GHV CUZ W3GHY CGV OR W8OMY



FGV QXV CLS CIR QQS W9VPN QCY UDO UNS GFW LLM KFK DAX (Not the old Sandwich man and crystal grinder, Leon Faber, is it?). Leroy thought that most of the skip passed him, because contacts were hard to get! W5DXW in Texarkana did not do badly, either, raising W1AVV W2AMJ HWX BYW W3OR ASD FJ AXU GHY CGV W8CIR QXV QQS CLS FGV and hearing W1HDQ and several W9's. W7ERA heard W5JGV working W7FFE FDJ. W8RUE must have been right in the middle of the skip to the Fifth District, for he worked W5FSC DXB and heard W5WX DNN AJG ZS EHM AKI DXW CQV HYT HTZ AFX. W9AQQ in Indiana raised W4FBH W5AJG HYT EHM and heard W5CHG AFX AKI W9PKD, while W9QCY hooked W5AJG HYT AFX. W9WWH in Wisconsin worked W5ATH and heard W4FBH W5EHM AJG AFX HYT HTZ.

*June 26.* Still more on the decline, the band gave W5DXW a few weak signals that were not identified, and a pulsating background noise in his receiver. Again without giving calls, W9YKX states that the band was open to W1-3-7-8 but we have no other reports at all on the day's work.

*June 27.* W9AQQ heard W5's but did not raise any. All of the fun went to the western districts where W7ERA hooked W6QLZ ANN SLO LFN OFU QAP QG OVK in what must have been a hot patch of layer, producing R9 signals. W6OVK enjoyed working W7DNB FFE ERA FDJ in a two-hour opening, hearing W7AMX and possibly raising W7WP/7 mobile. W6QAP hooked the same four W7's and AMX as well. W6SLO got all five of the W7's and also heard W7HEA.

*June 28.* This has been mentioned before!

*June 29.* Not a bad day, this one. W2BYM raised W9DQU and also W9YKX whose signal, Mel says, was the loudest ever heard, as it was 20 to 30 db above S-9 on an S-27 receiver. W5AJG did reasonably well in two openings, working W6OVK QAP SLO W8QDU QXV OMY QYD TDJ BPQ CYE W9AB HUV DQU ZHL CLH ANH AQQ. At noon, W5DXW heard a W4 whom he thinks is W4EDD; he also worked W5JGV W6SLO OVK QAP W8KKD QDU and heard W6QLZ. The band opened three times for W6SLO starting with W5HTZ AJG in the morning, W6QG OFU HDY LFN in the afternoon and W5HTZ JXS ATH EYZ in the evening. W6OVK took in W6QG W7FFE in the end of the afternoon session and W5HTZ AJG ATH DXW JXS EYZ in the latter part of the evening opening. W6QAP raised W6QG W7ERA and heard W6LFN OFU in the afternoon opening and hooked W5JXS DXW HTZ ATH AJG EYZ in the evening. W7ERA con-

[*Continued on Page 83*]

## A Deluxe Multi-Band V.F.O. Exciter

[*Continued from Page 13*]

and is connected to the transmitter on-off control system. Filament, heater, and plate voltages are fed into the exciter unit by means of a 6-conductor cable. Because of the drop in the cable, the filament transformer is a 7.5-volt type instead of 6.3 volts. Resistors of small ohmic value were inserted in series with the transformer secondary to bring the voltage at the sockets of the tubes in the exciter down to exactly 6.3 volts. The value of resistance to be used must be found by experiment, as it depends upon the length and wire size of power cable used.

### Operation

Under operating conditions the currents to the various tubes are approximately as follows:

| | | | | |
|---|---|---|---|---|
| 6V6 | 160 m. | doubler | — | 25 ma. |
| 6N7 | 80 " | " | — | 50 " |
| 6V6 | 80 " | xtal | — | 15 " |
| 6N7 | 20 " | doubler | — | 60 " |
| 6N7 | 20 " | " | — | 70 " |

After the exciter has been turned on, the bandswitch should first be set to the 80-meter position, and the two doubler stages tuned for maximum output or minimum plate current. The e.c.o. should be set to the middle of the 160-meter band. The bandswitch should then be set to 20 meters, and the 6V6-6N7-6N7 sequence of doublers should be tuned in that order. The crystal-e.c.o. switch should be moved to each crystal position, and a check should be made to insure that each crystal starts oscillation. If any one does not start when the switch is thrown to its position, the plate condenser of the 6V6 should be retuned slightly.

Once all tuning condensers are set by the above procedure, they need not be reset at any time, unless the band-set trimmers on the e.c.o.'s are changed to another position.

### Results

The results obtained from this exciter have been very gratifying to the writer. At present the unit is used to drive an 813 buffer amplifier to over 250 watts output. The exciter output is essentially the same on all bands because the doublers have a definite power gain, and each successive stage is driven harder so that decreased tank circuit efficiency is compensated for by the additional excitation. The output measured with a dummy load resistor and an r.f. milliammeter was very close to 5 watts on all bands. Outputs of over 8 watts were easily obtained by increasing the plate voltage on the doubler tubes from 300 to 400 volts.

The exciter was found to have excellent frequency stability, and the drift was only 100 c.p.s. per hour at 14 Mc. The exciter was first put into operation in the last SS contest and it handled perfectly, allowing almost instantaneous bandswitching and very rapid and accurate frequency shifting. It was possible to reset the frequency of the e.c.o.'s to within a few cycles of zero beat, even on the 20-meter band, without difficulty.

## F.M. for Ten

[*Continued from Page 22*]

initial tuning is likely to lead to damage of the tubes. Power for the exciter should be supplied by a pack capable of delivering 250 to 300 volts at 80 to 100 milliamperes and 6.3 volts at 3 amperes.

A small panel lamp coupled to a 3- or 4-turn loop should be used to set each stage to resonance. Simply couple the loop to each tank circuit, starting at the crystal plate coil, and tune each stage for maximum output. If the coil data are followed accurately, it will not be possible to hit any harmonic but the third in the tripler plate circuit, so there need be no worry about tuning the tripler to the wrong harmonic. The output in the 6K8 plate circuit will not be very great, but it should be sufficient to light the pilot bulb.

After the preliminary tuning, the 6SA7's may be replaced in their sockets and $C_1$ and $C_2$ returned to compensate for the capacity added by the tubes' grids and plates. $C_{10}$ should be set for about 20 $\mu\mu$fd. (movable plate about half screwed down). Speaking into the microphone while listening on a receiver tuned to 1800 kc. should reveal that a frequency-modulated signal is being produced. The operation of the deviation-increasing section of the exciter may be checked by comparing the 1800- and 1850-kc. signals; the 1850-kc. signal should be much more heavily modulated.

The output from the exciter, while not great, is enough to excite a small receiving tube as a doubler to 80 meters. A 6SJ7, 6V6, 6F6, or 6L6 would be the most suitable tube to follow the exciter.

### Crystal Frequencies

The 1800- and 7250-kc. crystal frequencies need not be strictly adhered to. The only requirement in the choice of crystals is that the difference in frequency between the third harmonic of the low-frequency crystal and the high-frequency crystal fall in the range between 1828.2 and 1875 kc., for operation in the 10- and 5-meter f.m. bands.

•

A vessel signing WDMU is named *WDGY.*

## A Self-Synchronous Direction Indicator

[Continued from Page 25]

most cases can be neglected. The resistance of the indicator with the Gramme ring connected varies from about 40 to 60 ohms as the beam antenna rotates, so the influence of this change should be considered, although in practically all circuits it could be neglected. For instance, in a 500-volt circuit carrying 250 ma., the total equivalent resistance would be 2000 ohms. If the indicator were placed in series, this resistance would vary from about 2040 to 2060, a change of only 1 per cent. Compared with line-voltage fluctuations of 5 per cent to 10 per cent, this is nothing.

Needless to say, the Gramme ring coil can be constructed in a number of forms, but when the first one works so well, there is little point in exploring the field. Thanks for the neat construction of this coil must go to "scrapiron" Joe Naemura, W7GXA.

## Five-Meter Summer DX

[Continued from Page 80]

tacted W6QAP QG ANN UAH HDY QUK SJB and heard W6SLO. W9YKX found the band open to W3 rather than to the west. W9WWH worked W5DNN and heard W5AJG FWS in the morning, and heard W1HDQ NCQ to the east in the afternoon. In Indianapolis, W9AQQ worked W5HYT FWS AJG and heard W1CVU(?) working W8's about which we have no other information, other than that W9ZJB raised W8QQS CLS LZM (LZN?). That finishes June, 1941.

### More July Data

*July 1.* A single report for this day comes from W9AQQ in Indianapolis who reports hearing but not working W5's.

*July 2.* The band should have been open all day, according to W5AJG who heard only W9ZTL in North Dakota and learned that it was wide open for Amarillo, Texas, and for Oklahoma. We cannot tell much about openings for W5HTZ since June 23 because Merlin found too many openings to list separately. W6OVK found signals to be fading but he raised W8KKD on c.w. and W9YKX who was R9 plus, and heard W5AFX HTZ HYT W8CIR RKE W9ZHB FZN NFM. Jim's neighbor, W6QAP, hooked W5HTZ W9YKX and logged W8CIR W9OLY NFM. Bill Copeland, W9YKX, says that the band was open to both W6 and W7. In fact, the only signal that W9PKD in Kansas heard was W7ACD whom he could not raise with his

beam end on, but who came right back for a half hour contact when the antenna was turned. The W7's only were coming through on ten meters, too, at the time. W9WWH in Racine worked W5HTZ and heard W5JGV in New Mexico and W5HYT. W9ZJB raised W5JGV, and W7IFL in Wyoming, hearing W6OVK ANN QLZ W7ACD GBI on an indoor half-wave antenna used for both transmitting and receiving.

*July 4.* In New Jersey, W2BYM reported W4FLH W5HTZ W9ZJB HAQ PK OLY AHZ CCY PQH, mentioning that W5HTZ often flutters in when nothing else is heard—probably being one of those cases of just about maximum possible single hop distance which may open more frequently than shorter distances. W9AQQ had contacts with W1KTF NCQ AEP. In Salina, Kansas, W9PKD got only W8EPM of Owasco, New York. In Iowa, W9YKX, found the band open to W3 and W8. W9ZJB worked east, too, getting W1CLH KLZ LLL KZU W2BYM AMJ W3HFY AXU W8CFD CIR for his best day of the summer, still using the half-wave doublet in his room for transmitting and receiving as he did in working the west coast two days before, but such is not recommended for getting in on the poorer openings. This day, like July 2, appears to be rather wide open for those in the right places.

*July 5.* This probably does not belong in the skip story, but W2BYM worked W1HXP W8QQP W9UNS on aurora skip, though the last seems far enough to be on sporadic-*E* skip if there is anything to W1DEI's explanation of aurora-type dx.

*July 6.* Now we are getting into about the best stretch of openings of the month. With W5JKM operating, W5AJG worked W6ANN QG in California. W6OVK had to work during the opening in the morning, but W6QAP raised W5HTZ AFX W6QG ANN LFN AVR and heard W7ERA. W6SLO also raised W6QG AVR ANN LFN on the very short skip. W7ERA hooked W6QG ANN AVR, which implies that the layer was not only turning the signals down strongly and at short distances, but also it was rather extensive over the southwestern states.

*July 7.* This was not such a bad day for W2BYM who connected with W4BBR DYH FBH W5HTZ AFX JXS W9ZJB. It was relatively poor for W5AJG who got only W8GU (what, Bliley the crystal man?) and W8BPQ QUO VIB. W9AQQ did not contact the W1 and W5 stations that he heard. In Kansas, W9PKD found the band open for an hour with fading signals, no one station staying in very long; he worked W3AXU W8AOC KWL, for one new district and two new states, KWL being in West Virginia. And Dawson hooked W1HDQ W2AMJ BYM W8KKD KWL from W9ZJB in Kansas City.

*July 8.* A better day, covered above in detail.

*July 9.* Leroy May writes from W5AJG: "Tonight as I am writing this summary, I hear at 8 p.m. W6QLZ and W6QAP, but I have to finish this thing now or never, and they seem busy working other stuff. They are tired of working me noway." What devotion! As a matter of fact, W6QAP must have been having a field day, starting with hearing W7CIL at 10:30 a.m., working W6ANN, hearing W6SJB, and at one o'clock starting an hour R9 plus contact with W6BPT; nothing more until 6:27 after which he hooked W5HTZ HYT W7IFL FLQ W9ZJB and heard W7GBI ACD FDJ CIL W9AQQ YKX, leaving the band when it was still hot at 8:30. It was also a nice opening for W6OVK who worked W5HTZ JXS HYT W7GBI FLQ FFE FDJ AMX DNB ACD W9AQQ ZJB YKX and heard W6ANN QG W7IFL CIL during the evening part only. Nine W7's and seven of them worked means either that it was a very hot opening or that there is a great deal of W7 activity, or both. As a matter of fact, they include *all five states* in the district. W6SLO raised W6SJB ANN UAH in the very short skip in the morning and W5HYT W6BPT W7GBI FLQ ACD CIL FDJ FFE W9ZJB, which includes every W7 state except Wyoming. W7FDJ and W7FFE worked W5HYT JGV W6QLZ OVK SLO. In Kansas City, W9ZJB raised the whole "Tooks on" gang, W6SLO QAP OVK, and heard W5JGV W6QLZ. In Indiana, W9AQQ got only W6OVK. All in all, this must rate as a rather good day for the western part of the country.

*July 10.* On a very poor band, W5AJG worked only W9DWU. W6OVK heard W7FDJ ERA CIL AMX mostly trying to work W5's. In Oregon, W7ERA reports working W5JGV W6OVK and hearing W5BDB or another Texarkana, Arkansas, station on about 57,150 kilocycles. W9QCY in Fort Wayne had a loud contact with W5HYT.

*July 11.* During some good low atmosphere bending contacts, W2BYM took time out to hook W9PK in the late evening. W5AJG got W5JGV W6OVK SLO; New Mexico is rather short skip for Leroy. W6OVK worked W5AJG EHM CVQ (CQV?) W6NHO W7FLQ and heard W5JGS and W5ML; Jim was too late in locating ML who was way up on 58.1 megacycles, and the band went out before he could make a contact. All signals were R9 plus except W7FLQ. Also in Tucson, W6QAP worked W5EHM JXS CQV ML and heard W5AJG DNN W6NHO W7FLQ W9BDL YKX. W7ERA worked W6SJB, and W7FDJ got W6HDY. In Salina, W9PKD heard and worked only W9LLM. W9WWH up in Racine returned from his vacation to get

back into his W5 habits to hook W5HYT CHG and hear W2BYM W5AFX HTZ W7IFL. For that matter, the way that WWH gets those W7's every few days is a phenomenon.

*July 14.* In a short opening, W2BYM grabbed off a contact with W9FZN. Joe Addison, W9PKD, got W8FYC for his 13th state (poor days seem to be Joe's meat); and W9ZJB hooked W8QDU LZM (LZN?).

*July 16.* This was a little better. W2BYM raised W5AFX W9STX NYV. W4FKN worked W3IIS W8QDU QQS MYZ W9QIN/9. W9ZJB also did quite well, contacting W1HDQ W3CYW IIS W8CIR FGV QQP TDJ KWL. W5AJG found the band in fair shape but with few signals; he worked only W2AMJ W8JLQ. W9WWH heard W4AUU DXP W5HTZ HYT W7IFL; he complains that Chicago stations often hear W7's loud but he gets them only weakly and for a short time—as on this evening.

*July 18.* W2BYM did some work down the coast with W4FVW DXP at the other end. On the back of a card giving the "Cowboy's Prayer," which does not say anything about asking for more five-meter openings, W6OVK reports working W7FFE AMX FDJ and hearing W7ERA after having checked ten meters as open only to W5; anyhow, Jim, five was open. W6QAP raised W7FFE AMX FDJ and heard W7ERA just as Jim did. Walt Manning, W7ERA, got on late to work W6SLO after W7FDJ and W7FFE had worked W6QLZ OVK QAP.

*July 19.* W2BYM worked only W9ZJB, who also got W8EPM in the morning opening while W8's in Michigan and W2's were coming through on ten meters too. In the afternoon, W6OVK heard W5HTZ working W5AFX on ground wave. W6QAP was able to work HTZ.

*July 20.* In another poor opening for Dallas, W5AJG made connections with W6SLO W8CIR QQS. W6OVK enjoyed loud but fading signals in contacts with W5FCD DNN W7FFE W9ZJB, saying goodbye to the latter on what might have been their last opening before Vince left for Washington, D.C. W6QAP hooked up with W5EHM W9ZJB but missed on W5FCD DNN AJG W7FFE. W7ERA heard OVK for only a few minutes. W9ZJB had contacts with the Arizona gang, W6QLZ QAP OVK SLO.

*July 22.* As if one good-bye was not enough, W9ZJB repeated it to W6OVK QAP who were R9 for two hours. QLZ and some fading W5's were heard weakly. W5AJG enjoyed a fair

opening, contacting W8LZN QQP RKE KQC RFW W9PK QCY IOD ZHB. In Tucson, W6OVK worked W5AFX W7IFL GBI HEA ERA FFE FLQ W8KQC QDU RKE W9ZJB AQQ AHZ PKD, all R9 except W8KQC, even the two-hop signals. In the four-hour opening, W6QAP hooked W5HTZ W7IFL ERA GBI FLQ FFE AMX W9AQQ JPB ANH BDL ZJB PKD ZHL and heard W7HEA. W9PKD in Kansas raised W6SLO QAP OVK in Tucson while the ten-meter band was open for fading W5-6-8 signals, which indicated just where all of the five-meter openings were, but not all for him. During an electrical storm, W9WWH heard W5EHM AJG ZF. W9AQQ in Indiana got W5CHG FWS W6QAP SLO OVK for some one- and two-hop contacts, with W9ZJB getting to AQQ's mike in person in time for a ground wave contact with W9QCY. QCY had raised W5AJG EVI. It appears that a considerable part of the country from the northwest to the southwest and across W5 to W8-9 was in on this opening, wherever there was activity on the band. Only W1-2-3-4 on the east coast were not reported.

*July 27.* W5AJG got W8NYD W9ZHB and a doubtful contact with W7GBI. W6OVK had a three-hour opening in which he worked W5CHG AAN HTZ W7GBI and heard W5DNN AFX W9PKD; all signals hit R9 on peaks except W5DNN. W6QAP had a shorter opening, apparently, in which he hooked W5HTZ and heard W5CHG AAN AFX W7GBI. After QAP gave up, W9PKD raised W6SLO.

[*Continued on Page 94*]

## 56 Mc. DX HONOR ROLL

| Call | D | S |
|---|---|---|
| W5AJG | 9 | 38 |
| W5HTZ | 9 | 29 |
| W8CIR | 9 | 35 |
| W8RKE | 9 | |
| W9AHZ | 9 | 16 |
| W9AQQ | 9 | 25 |
| W9CLH | 9 | 23 |
| W9GHW | 9 | |
| W9GJS | 9 | 22 |
| W9NYV | 9 | |
| W9QCY | 9 | 25 |
| W9USH | 9 | 18 |
| W9USI | 9 | 24 |
| W9WAL | 9 | |
| W9YKX | 9 | 22 |
| W9ZHB | 9 | 43 |
| W9ZJB | 9 | 28 |
| W9ZQC | 9 | 26 |
| W1DEI | 8 | 20 |
| W1EYM | 8 | 20 |
| W1HDQ | 8 | 26 |
| W1SI | 8 | |
| W2BYM | 8 | 27 |
| W2GHV | 8 | 24 |
| W3AIR | 8 | 24 |
| W3BZJ | 8 | 27 |
| W3RL | 8 | 29 |
| W5AFX | 8 | |
| W5DXW | 8 | 21 |
| W6QLZ | 8 | 22 |
| W8JLQ | 8 | |
| W8QDU | 8 | 25 |
| W8QQS | 8 | 17 |
| W8VO | 8 | |
| W9ARN | 8 | 17 |
| W9CBJ | 8 | |
| W9EET | 8 | 15 |
| W9VHG | 8 | |
| W9VWU | 8 | 16 |
| W2AMJ | 7 | 22 |
| W2JCY | 7 | |
| W2MO | 7 | 25 |
| W3VYF | 7 | 22 |
| W3EZM | 7 | 24 |
| W3HJO | 7 | |
| W3HOH | 7 | 17 |
| W4DRZ | 7 | 22 |
| W4EDD | 7 | |
| W4FBH | 7 | 17 |
| W4FKN | 7 | 16 |
| W4FLH | 7 | 18 |

| Call | D | S |
|---|---|---|
| W5CSU | 7 | |
| W5EHM | 7 | |
| W6OVK | 7 | 22 |
| W8CVQ | 7 | |
| W8OKC | 7 | 12 |
| W8PK | 7 | 9 |
| W8RUE | 7 | 18 |
| W9BJV | 7 | 15 |
| W9GGH | 7 | |
| W9IZQ | 7 | 14 |
| W9PKD | 7 | 13 |
| W9SQE | 7 | 22 |
| W9WWH | 7 | 26 |
| W9ZUL | 7 | 18 |
| W1LLL | 6 | 24 |
| W1CLH | 6 | 13 |
| W1JFF | 6 | 11 |
| W1KHL | 6 | 11 |
| W1JJR | 6 | 17 |
| W2KLZ | 6 | |
| W2LAH | 6 | |
| W5VV | 6 | 18 |
| W8LKD | 6 | 11 |
| W8NKJ | 6 | 16 |
| W8OJF | 6 | |
| W8PKJ | 6 | 12 |
| W9NY | 6 | 13 |
| W9CJS | 6 | |
| W1GJZ | 5 | 15 |
| W1HXE | 5 | 18 |
| W1JMT | 5 | 9 |
| W1JNX | 5 | 12 |
| W1JRY | 5 | |
| W1LFI | 5 | |
| W2LAL | 5 | 11 |
| W3CGV | 5 | 10 |
| W3EIS | 5 | 11 |
| W3GLV* | 5 | |
| W3HJT | 5 | |
| W4EQM | 5 | 8 |
| W6DNS | 5 | |
| W6KTJ | 5 | |
| W6QAP | 5 | 14 |
| W6SLO | 5 | 19 |
| W8EGQ | 5 | 10 |
| W8NOR | 5 | 16 |
| W8OPO | 5 | 8 |
| W8RVT | 5 | 7 |
| W8TGJ | 5 | 9 |
| W9UOG | 5 | 8 |

Note: D—Districts; S—States.

## A 12-Element Rotary for 56 Mc.

[*Continued from Page 35*]

### Construction

Figure 1 shows a side detail of the beam rack and rotating head. The tower uprights are $1\frac{1}{8}$ inches by $1\frac{1}{8}$ inches. The bracing material is $\frac{3}{4}$ inch wide by $\frac{1}{4}$ inch thick. The upper and lower rack side rails are standard 1 by 2. All four sides of the upright tower are identical. Two sides are built, being careful to get them square. Then they are turned up on edge and the braces put in place to complete the remaining two sides.

Figure 2 shows a top view of the upper and lower racks. They do not require much bracing as they are held quite firmly by the upright tower and the element supports. The element supports are 1 inch by 2 inch pieces, 5 feet long, and the elements are mounted on stand-off insulators by means of U-clamps. The spacing between the center insulators should be about $3\frac{1}{2}$ inches so that the inside ends of the elements may be spaced about 2 inches. The elements themselves are $\frac{1}{2}$-inch dural tubing with slotted ends so that $\frac{3}{8}$-inch tubing may be slid in or out to adjust the length. Clamps around the slotted ends hold the sliding pieces in place after adjustment.

Figure 3 shows a detail of the phasing section and Q bars. Number 4 Kearney connectors are screwed to the ends of the Q bars which are flattened just enough to accommodate the screws. They may then be screwed in or out to adjust the spacing and then tightened up on the no. 4 phasing section wires. The Q spreaders are staggered as shown to permit closer spacing of the bars.

The Q bars leave the phasing section at an angle of about 15 degrees, and are anchored to the outside of the upright tower on stand-off insulators. A 5-foot section of 2-inch line was made up of no. 14 rubber-insulated house wire with spreaders every 6 inches. This section of line fastens between the main feeders and the Q bars and may be rotated nicely without much distortion of the spacing.

The main support of the whole beam is the top of the rotating head and is shown as solid black in figure 1. This is a 14-inch piece of 13-inch channel iron. The upright tower fits over the outside of the 4-inch channel, and the bottom rack slides inside. They are held in place by stove bolts making the whole assembly very rigid.

The rotating head is made from a Ford front axle. It is welded to a cap made from $\frac{1}{4}$-inch boiler plate. Two arms of the same material are welded to the cap, as shown in figure 1. Two generator pulleys are mounted on these arms. The large pulley is built up from 3 pieces of 1-inch board. The whole assembly bolts between the wheel plates, just as the wheel originally did.

The whole beam does not weigh more than 40 or 50 pounds and may be handled quite easily. The writer believes that any one who builds an array of this sort will be highly pleased with its performance.

•

The United States with seven percent of the world's population has over eighty percent of the world's hams.

•

## Grid Dip Oscillator

[*Continued from Page 45*]

crystal was used. Unless the constructor is especially ambitious and calibrates the instrument for use also with the capacity leads, it is best to use a receiver or some other device to determine the frequency accurately under these conditions. Another alternative is to leave the inductive coupling cable connected at all times and to provide a separate terminal for the capacity coupled output.

By connecting the receiver i.f. crystal across the capacity output of the oscillator, the exact frequency for i.f. alignment of the receiver can be obtained. By operating the oscillator with the modulated plate supply, the difference of note can easily be heard when the oscillator locks in with the crystal.

By connecting the capacity coupling leads from grid to ground on a receiver r.f. stage, the tracking of the stage may be checked. If the signal is heard in the receiver and the eye opens at the same frequency, the receiver is tracking properly. This test should be used only when there is a considerable amount of capacity present across the circuit so that the few $\mu\mu$fd. added when the test clip is attached to the receiver will not detune the circuit being checked.

The natural frequency of antenna and feeder systems may readily be determined by properly coupling the oscillator to these systems. In addition to these specialized uses, the oscillator may be used in connection with a standard of almost any frequency for the calibration of receivers and other oscillators, and by itself it can be used to furnish a signal for the alignment of receivers.

### Use as a Wavemeter

With the plate voltage removed from the oscillator tube, the instrument may be used as a sensitive wavemeter. This enables the operator to pick the correct harmonic from the output of his harmonic oscillator or harmonic amplifier. In the case of a persistent parasitic oscillation, the frequency of this oscillation may be determined, and then suspicion may be directed to the guilty part of the circuit.

As has been mentioned previously in the article, the instrument described is almost entirely descended from the junk box, resulting in certain compromises with best engineering practice. Those having more time and parts available may improve upon various points which have been mentioned during the article. Since every constructor has his own ideas about construction, no step-by-step layout has been included. We still believe that the instrument is well worth the $3 we have invested in it.

## A Perfect-Balance Self-Balancing Phase Inverter

[*Continued from Page 46*]

this unbalance can be removed by an extremely simple device; make $R_4$ slightly larger than $R_3$.

The exact value of $R_4$ for perfect balance will be developed from the following analysis. Denote by $\alpha$ the ratio $R_5/(R_3 + R_5)$, by $\beta$ the ratio $R_5/(R_4 + R_5)$, and by $m$ the voltage gain (without feedback) of tube $T_2$.

For convenience, let voltage $E_a = 1$. Denote the voltage between point (a) and ground by $a$. Then voltage $E_b = ma$. Inspection of the circuit shows that

(1) $$a = \alpha - \beta\,(ma).$$

Solving for $a$:

(2) $$a = \alpha/(1 + m\,\beta).$$

Hence

(3) $$E_a/E_b = (1 + m\,\beta)/(m\,\alpha).^3$$

Therefore, in order that $E_a/E_b = 1$ we must have

(4) $$\alpha = \beta + (1/m).$$

This gives us the following general principle: *in order to get perfect balance, choose resistors* $R_3$, $R_4$, $R_5$ *so that* $\alpha = \beta + (1/m)$, *where* $\alpha = R_5/(R_3+R_5)$, $\beta = R_5/(R_4+R_5)$, and $m$ = gain of tube $T_2$.

It is very easy to apply this general principle. Let us consider, for example, the 6SC7 case above. Here, as we see from the tables on resistance-coupled amplifiers, $m$ is equal to 42. Leaving $R_3$ and $R_5$ (and $R_1$ and $R_2$) unchanged, it turns out that for perfect balance it is only necessary to change $R_4$ to 275,000 ohms.[4] This gives a "perfect-balance self-balancing" phase-inverter circuit, which in a single tube yields a voltage gain of 84, grid to grid.

The modified circuit retains, of course, the valuable feature that variations in tube gain affect $E_a/E_b$ very little. Thus, a 25 per cent decrease in the gain of section $T_2$ of the 6SC7 above would create an unbalance of less than 1.6 per cent.

[3]Thus in the usual case in which $\alpha=\beta$ (i.e. $R_3 = R_4$) we see that $E_a/E_b = 1+(1/m\beta)$, the term $(1/m\beta)$ representing unbalance.

[4]Best results require that resistors $R_3$, $R_4$, $R_5$ be actually measured, although only their ratios need be determined really accurately. If one relies on ordinary 10% tolerances, one cannot guarantee less than 10% unbalance (15% in the earlier 6SC7 case). This necessity for precise resistor ratios is not a peculiarity of the modified self-balancing circuit given here, but is characteristic of *all* vacuum tube phase-inverters, of whatever type: *no known vacuum-tube phase-inverter gives any better balance than its resistor ratio tolerances.* In particular, a self-balancing phase-inverter may compensate for tube gain variations, but it cannot compensate for improper resistor ratios.

It is clear, since good balance requires accurate resistor measurement in any case, that one might as well make $R_4 = 275{,}000$ ohms and get perfect balance as make $R_4 = 250{,}000$ ohms and get 5% unbalance.

## Yarn of the Month

[*Continued from Page 64*]

mind a bit, as long as it relieved his rheumatism. Daddy was really about the—"

"That old coot!" Walter was snarling.

"What was that, Walter?" Phyllis was aghast. (Whatever that is.)

"Such people are a menace to the community. They ought to be tarred and feathered! Why, they should have been sprayed with Flit the day they were hatched. T——!!"

"Walterrrrrrrrrrr!"

"Why, that fat, old—" Smacko! Phyllis swung from the bottom of her little heels, and the uppercut connected in a manner of which even Joe Louis would have been proud.

"Mr. Smetz! You are speaking about my father. I think that you have gone far enough! And—"

"Phyllis!" This time Walt was aghast.

"And in the future you will please call me Miss Crumpitt. I think you had better take me home." Her nose went up another half inch.

"Phyllis, you can't mean this. Why—why if you cut me off like this, do you know what I'll do? I'll kill myself on the high-voltage supply of my rig! You'll be sorry."

"Don't forget to turn off the current when you're through," she came back in an icy voice. "Please take me home, Mr. Smetz."

Still later that evening, Walt was drowning his sorrow in a glass of grape-juice. Idly he twiddled the dials of his SQ-24. Sure enough, there it was—a fiendish, hideous snarl that was buzzing through everything on the band.

"Well," thought Walt, "I can at least tune up the rig again."

The filaments went on. He waited a couple of minutes. Then the plate supplies went on. He whistled into the mike. To his surprise, the needle on the final plate meter almost turned handsprings in its dizzy gyrations. He turned the rig off."

" 'Sfunny," he mused.

And like the ham he was, he had the rig half apart before he noticed that the antenna feeders were very, very slack.

Little lightning flashes of apprehension started to crackle through his head as he ran down the steps, two at a time, toward the back yard. The antenna was lying on the ground. He went to the far end and picked it up.

The insulator had been neatly smashed with a rifle shot.

Major Hugh Crumpitt let loose with a sigh which started from about three-quarters of the way down in the middle of his ample physique. Then he turned slowly and shut off the diathermy. Suddenly he perked his ears up. He listened.

"Snurff, snurff. BoooooHooooo! Sniff, snurf," he heard.

Now, let everybody understand that a retired Army Major is a brave animal. Therefore, pausing only to fortify himself with a jigger of —soda-water, Major Crumpitt started out in quest of these strange sounds. Presently he paused in front of his daughter's room. He cocked his head to the left side and listened. "Snurff—ffff. SNIFF," came from the room. The Major hesitated no longer. He knocked.

"Come in. (Sniff)." The Major waddled in.

"Why, my little turtle-dove, what's this? Tell papa what's the matter. Naow, naow." He stretched forth a big hamlike hand.

"It's Walter, papa. He's horrid!" She turned a tear-sprinkled face.

The Major chuckled indulgently. "Yes, dear, tell me all about him." He started to grin a Majorly grin, such as he used to use in the Army at his subordinates, who could not grin back.

"He's just moved into our block today. (BooHooooooo!) And can you think of such a thing, father? I started to tell him that you bought a diathermy machine, and he called you—he called you—"

"He called me—" The Major's walrus moustache quivered.

"He called you a—a fat old menace to the community!" The last words came out in a rush. Then the poor dear's shoulders started to heave. Again she started to pump salt water.

Just like in the comics, Major Hugh saw electric-light bulbs blinking on and off. Snorting like a bull elephant, he stalked out of the room.

"Muggins. MuugIINNNS! Where the deuce are you?"

"Yes, sir?" The little man rolled his eyes apprehensively, for the Major had little flecks of foam decorating his thick lips.

"Get my horse-whip. The one with the lead in the handle. Quick."

Muggins scurried off like a tarantula.

Ten seconds later, the Major, with more speed than dignity, was tramping down the sidewalk, his bloodshot eyes fixed straight ahead, and the tail of the whip trailing back of him, causing him to trip every fifteen feet or so. His moustache was twitching by now.

"Bzzzzzzzzzzzzp. BzzzzzzzzzzzzzzP! Bang. Bang." The doorbell rang erratically amid thunderous raps on the door.

Walt had just finished replacing the shot-off insulator, and was still in the back yard. He started through the house for the front door. He opened it with a grin which suddenly changed to a yelp as he beheld the choleric face of the Major on the horizon, and then—

Swish! The Major started to edge his way in. In fact, the Major pushed and shoved.

"Now I gotcha! Come back here, YOU! Bust up my radio programs, will you? You—you HAM!" The Major charged.

Under the terrific onslaught of the Army, Walt abandoned his position at the door and retreated toward a more strategic position at the top of the stairs. A pitched battle developed, in which Walt fared better than you might think, for his opponent, being a Major, was, of course, unaccustomed to fighting for himself.

Later, as Phyllis, remorseful, was hurrying toward the residence of Walter N. Smetz, W3RGH, she passed the Old Man, who was now a little drooped with the exertions of the battle, but who was still tramping majestically with the true Army spirit. His horse-whip trailed along behind him. Phyllis noted, with a shudder, that the whip looked quite tattered and shop-worn.

She walked through the open door, up the glass-strewn stairs, into the shack. Walt was sitting there, morose, his chin in his hands. (Don't get any false ideas. I mean that he was supporting his head, with the chin still attached, in the palms of his hands, something like Rodin's statue of "The Thinker.")

Walt lifted his head at the sound, his eyes brightened a little when he saw the Army's daughter, but then he sighed profoundly, and his head drooped again, like a wilted daisy after someone has sat on it.

"Gone. All gone. Not a single one left. Gone," he kept repeating to himself like a cracked phonograph record.

"What's gone?" Phyllis broke into the monologue.

"All my tubes—6L6G's, 807's, TZ40's—all of 'em. That's how I stood him off. Say," he broke out suddenly, looking her straight in the face, "is there anything the matter with your Old Man? Every time a tube popped when it broke, he jumped about ten feet. It's the only way I could keep him away."

"Yes, darling, that's why he was cashiered out of the Army. He couldn't stand the sound of a gun going off. But tell me, did you really stand up to Dad and hold him off like that?" Her eyes sparkled like one of those things you light on the Fourth of July.

"Boy, that was some battle," Walt reminisced. Then his face fell again. "Diathermy," he muttered.

"Silly boy. That's what I came to tell you about. When I found out from Muggins why Papa bought that machine—"

"Yes? Go on?" She was having increasing difficulty meeting Walt's eye. "Go ahead, what did you do?"

"When I found out—I went down into the cellar and got a hatchet and—"

"Phyllis, you don't mean it?" His eyes popped.

"Yes, Walter."

"Darling!"

"Sugar Plum."

"Honey Bunch."

Let's pull down the window shade for two minutes.

Suddenly, they broke apart as they heard a sharp "Ping!" followed by a slight rattle.

They ran out into the yard and found the antenna down.

Walt went up to the far end and picked it up. The insulator had been neatly smashed with a rifle shot.

●

W1LFB's initials are R. I. and strangely enough he lives in Rhode Island.

## U. H. F.

[Continued from Page 57]

Bud Keller at W6QAP puts 60 watts into a 35T final, using a four-element W6QLZ antenna. He finds that the Hallicrafters f.m.-a.m. receiver is a big help because it will pick up 42-48 megacycle f.m. stations scattered about the country, making better indicators of possible five meter openings than does the ten meter band. On June 5, his big day, he heard 14 f.m. stations at one time.

On July 5, W2BYM reported aurora contacts with W1HXP W8QQP W9UNS. This is the only aurora-type dx that has been mentioned in letters to this column in several months. Have there been other cases of it?

### 2½ METER HONOR ROLL

#### ELEVATED LOCATIONS

| Stations | Miles |
|---|---|
| W6KIN/6-W6BJI/6 (airplane) | 255 |
| W6QZA-MKS | 215 |
| W6BKZ-QZA | 209 |
| W6QZA-OIN | 201 |
| W6BCX-OIN | 201 |
| W3BZJ-W1HDQ (crossband) | 200 |
| W6FVK-BIP | 190 |
| W6NJJ-NJW | 175 |
| W1DMV/6-W6HJT (airplane) | 165 |
| W9WYX-VTK | 160 |
| W6KIN/6-W6OMC/6 | 140 |
| W6ADM-NJJ | 130 |
| W6IOJ-OIN | 120 |
| W2LBK-W1HDQ | 118 |
| W1HDQ-W2JND | 105 |
| W6BCX-IOJ | 100 |
| W1HDQ-W2IQF | 100 |
| W1HDQ-W2GPO | 100 |
| W6NCP-OIN | 98 |
| W1KXK-MNK/1 | 81 |
| W6IOJ-OIN | 80 |
| W6CPY-IOJ | 80 |

#### HOME LOCATIONS

| Stations | Miles |
|---|---|
| W1MON-W2LAU | 203 |
| W1LZB-W2ADW | 200 |
| W1LZB-W2NCG | 200 |
| W8CVQ-QDU (crossband) | 130 |
| W6QLZ-OVK (crossband) | 107 |
| W3BZJ-W1MRF | 130 |
| W1IJ-W2LAU | 105 |
| W3BZJ-W1LAS | 105 |
| W2ADW-W2LAU | 96 |
| W1LPO-W1KLJ | 92 |
| W1HBD-W1XW (1935) | 90 |
| W1JFF-W1IJ | 85 |
| W1JFF-W2KPB | 80 |
| W2LBK-W1IJ | 76 |
| W2LBK-W3BZJ | 76 |
| W1MWN-W2LAU | 75 |
| W1SS-BBM | 74 |
| W1KXK-IZY | 73 |
| W1MRF-W2LAU | 68 |
| W2OEN-W1LAS/2 | 57 |
| W2GPO-LAU | 50 |

### 1¼ METER HONOR ROLL

#### ELEVATED LOCATIONS

| Stations | Miles |
|---|---|
| W6IOJ-LFN | 135 |
| W1AJJ-COO (crossband) | 93 |

### Five Meter Award

In memory of De Motte H. (Dud) Little, W9VHG, deceased member of the Ultra-High Frequency Club of Chicago, an award will be presented by the U.H.F. Club to the amateur showing the greatest achievements on the five-meter band during the period January 1 to December 31 each year for the next five years.

The award will be known as the Dud Little Award. The first will be announced on March 14, 1942, for work in 1941, and the remaining four on the same day of subsequent years.

No amateur shall receive the award more than once. Amateurs eligible for the award shall have stations located in Illinois and states bordering it, including Michigan. Any amateur may nominate one or more stations from this area for the award. Nominations should be addressed to the secretary of the Ultra-High Frequency Club, Edward Hamel, in care of the Columbia Broadcasting System, 410 North Michigan Avenue, Chicago.

Members of the U.H.F. Club will act as judges and consequently are not eligible for the award.

### 2½-Meter DX

Our Rhode Island reporter, W1JFF, really gives us the dope. He says that there are some 30 stations on the band locally, that he has worked five states and W1LPO has hooked four. Some W2's claim six! JFF has worked W2KPB at 80 miles and W1IJ at 85 miles. W1LPO has raised W1KLJ in Bristol, 92 miles away. Fading on signals beyond 50 miles has been noticed just as on five meters.

An extra good night was July 5 when W1JFF hooked W1EYR KTB W2KPB ADW LJR NKO NCG BZB LAU LXO CET W3BZJ/1 (on Mt. Greylock, Mass.) located as far away as New Jersey, where one station was using only 5 watts input. Some new distance records for Fred Evans must have been set up but they have not been figured as yet. Also, W1LZB in Boston worked W2ADW on Long Island and W2NCG in New York city. Until we get this distance settled, let's call it 200 miles. The band was said to sound like ten when it is wide open.

W2MPY, operating mobile at Garrison, N.Y., lists activity on 2½ during a week in June, ranging from 20 to 275 miles airline, he says. The calls are: W1HMP DLY NCY MPO BI BLQ KZU LIH GJU LOP BYN AYN HXU FOI LAS CRS W2LMJ CBI IMJ ADW US GPO LIH QK CUJ GJU NKO LOC JVO MBH MPH MIV JRG LKI MBS HUR KDI PP LMB DZA JRX BCR LH KRG AIP JKK BZM KYK MCR LZY BGH.

The former W9AOB is now W2OEN at Middletown, New Jersey. He is one of the boys on a civilian job at Fort Monmouth. Some June activity was listed as W2MCG MO MIV LYW KWH W3BZJ HOH IWA. He says that W2KWH worked 53 miles on an HY615 transceiver. W2AER LNP are helping David with a 16-element beam on his hilltop, so look out you W1's and W3's! His best dx so far is W2CDG/2 at Bear Mountain, 70 miles, and W1LAS/2 at Chapaqua, 57 miles.

Out in Northern California, W6FVK went up Mount Saint Helena on June 1 and with 15 watts on a decapitated 76 modulated by a 6F6, he raised W6BIP operating in the Santa Cruz mountains. BIP had an HY75 working into a V beam (in the vertical plane?) whereas FVK just had a vertical. This is a good long haul, especially where bending is not as prevalent as it is in Southern California.

W6NJJ refers to his 175-mile contact with W6NJW listed in the honor roll and mentions that only one other station was worked from the same location on Mt. Lassen, which was W6ADM on Mt. St. Helena. It was also reported that W6BIP in the Santa Cruz mountains also heard NJJ, at a distance reported to be about 285 miles.

### 112 Megacycle Rigs

W1JFF puts 25 watts into a 6E6 with lines. His antenna is two half-waves in phase (double zepp?) seventy feet high, to which he adds, "vertical, of course." He says that some of the boys are fooling with concentric line receivers —to which we add that we hope they are using a 9001 r.f. stage in them, with the grids and plate tapped well down on the lines for good selectivity. W1BIL is reported to have one of them, and the boys are after him for the circuit.

W2OEN used an HY75 transceiver in the June field day, but now is going to higher power. W2BYM says that locals include W2OCP NIE KKZ HFT. W1HDQ came through at 155 miles on July 31, but BYM believes in horizontals and insists that HDQ put the rig on his rhombic. What, a revolution on 2½ meters now? Mel wants to hear from some good 2½- and 5-meter rigs in Washington; possibly there will be some in a few months but unless a very few choice locations in the District are used, not much will be heard except those on the hills in Virginia and especially Maryland, up out of the Potomac Valley.

The 112-Mc. rotary three-element beam used at W3FZ, Bethesda, Maryland.

That should be enough u.h.f. dope for this issue, considering the five meter story, so goodbye until the November issue comes out with the rest of the dope; and don't forget to contribute your bit of interesting news, photos, or comments on equipment, and so on.

## 5-Meter Summer DX

[*Continued from Page 86*]

*July 28.* W6OVK found the band open to California for hours, with diathermy and W6 harmonics from ten meters heard. The only station on the band was W5HYT who was R9 plus, while ten meters was open to Texas and Arkansas also. W6QAP heard W5HYT ML.

*July 29.* The east coast got in on the dx this time, with W2BYM hooking W8RKE ARF BPQ QUO W9EGQ PMQ LLM YLV AKF ANH LF VZP WWH ZHB for a good opening. W6QAP out in Arizona worked W9TKX but did not report any two-hop skip into the east. W9AQQ in Indianapolis netted twenty contacts including W8-9 up to three hundred miles and skip contacts with W1CLH KLJ IJ HXP SI W3HDJ W4DXP FLH. W9QCY in Fort Wayne lost W1KLJ but gave W1HDQ an R9 report about three plus signs.

*July 31.* W5AJG worked W7ACD with conditions spotty. Similarly, W6OVK found conditions either very poor or no one on the band in the right places; several carriers and a fluttering i.c.w. signal were heard, and W5HTZ W9PKD were logged. W9PKD heard W7ACD working a W5 station.

## Early August Openings

*August 1.* To start the month off, W5AJG had a fine contact with W7ACD for twenty-five minutes and another with W6OVK. W9PKD worked W6SLO OVK with very good signals both ways. W6OVK SLO heard W9YKX YDC FZN working ground wave, but they were unable to break in; then OVK worked W5AFX EHM W9PKD LTB UZX with good strength, but EHM had the old hollow flutter on his signal so they used straight c.w. which did not fade. After watering the lawn, Jim came back to find W5EHM working W6QAP, so he went to work on W5EHM AAN AJG and also heard W5CHG HYT W7IFL. This was one of Jim's best openings to the east so far as absence of fading on one-hop signals is concerned, but proper activity was lacking.

*August 2.* Russ Law, W4FKN, got in on this one to work W8RNP QQS RKE W9WWH and to hear W5ANN EHM. In Lakehurst, W2BYM did rather well raising W4FLH AUU W5AFX EHM AAN. Leroy, W5AJG, worked W4FLH and heard W2BYM TP AMJ W4DXP.

*August 10.* Down in Cromwell, Oklahoma, W5HTZ was looking for something to happen on the morning of the August u.h.f. relay. He heard several skip signals but the only one identified was W8FGV in Ohio.

So there you have it, boys and girls. There may be more unreported dx, and probably is plenty of it, but after writing over sixty pages


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(c) Closing date (for classified forms only): 25th of month; e.g., forms for March issue, published in February, close January 25th.

(d) No display permitted except capitals.

(e) Used, reclaimed, defective, surplus, and like material must be so described.

(f) Ads not relating to radio or radiomen are acceptable but will be grouped separately.

(g) No commissions nor further discounts allowed. No proofs, free copies, nor reprints sent.

(h) Send all Marketplace ads direct to Santa Barbara accompanied by remittance in full.

of manuscript, our urge is to call everybody a dirty name just to see how many read far enough to get sore about it. But all kidding aside, fellows, are you going to be with us in the aurora skip, the few real skip days and possibly the December openings if they recur this year? After all, W9ZJB/3 can claim some contribution to activity—a contact from Maryland across the District of Columbia to Charlie, W3AWM, and another to W3FJ at Fort Meade, using an indoor antenna on the mobile rig converted for fixed-station use. Let's keep up the good work, amusing ourselves no end with ground wave dx and what skip there is, reporting activity and interesting little items to Jo Conklin, W9SLG/3, from time to time.

## *Aircraft Frequency Changes*

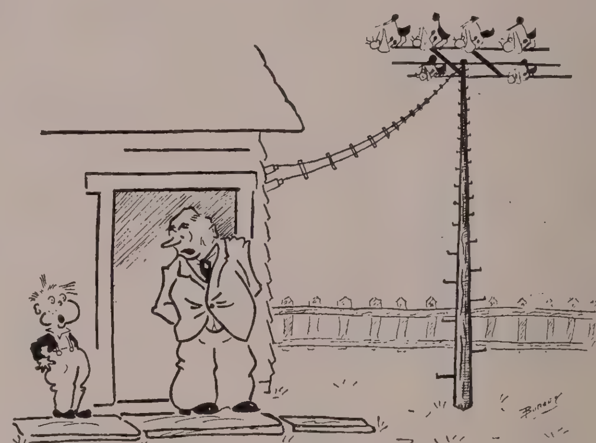
On recommendation of the Defense Communications Boards, the FCC has withdrawn the frequency 3105 kc. from use by *scheduled* aircraft and substituted the frequency 3117.5 for such use. This action, prompted by congestion on 3105 kc. and communication needs for off-route flights of aircraft in connection with defense, necessitates the withdrawal of the frequency 3120 kc. from availability for assignment to aircraft. The latter frequency is little used at the present time, and the private flier will benefit materially by having exclusive use of 3105 kc. The change does not involve modification of existing aircraft licenses.



## *Ship Radiotelegraph Operator Requirements Modified*

To help meet the demand for radiotelegraph operators in the expanding United States merchant marine, the FCC has ordered suspension for six months of the requirement in Section 13.61 of its Rules Governing Commercial Radio Operators that such operators possess six months' previous ship service to be eligible for employment as the single radio operator on a cargo ship.

This suspension of the six-months-service requirement is intended to help in meeting the shortage of operators. The same license requirements still hold. Under the Commission's order, graduates of the Maritime Commission's radio schools who have secured FCC licenses will be eligible for employment on cargo ships.



"All I sent was 'QRU?'."

## *CQ CQ CQ*

"CQ," screamed the ham, at his microphone—
His eyes held a desperate stare;
"CQ," was the cry that he uttered again,
Like a soul that was sunk in despair!

"CQ," once more, were the words which came
From the lips of this desperate guy;
As he zipped up the gain on his audio,
And prepared for another try.

"I'm calling CQ, won't some one come in?
Won't some one please answer my call?
Won't some other amateur give me a buzz
Before I break down here and bawl?"

But, no one came back—there was nary a peep;
From out of the ether came naught
But a bunch of fried hash, QRM, QRM:
QSO's were just not to be got!

"I quit," said this nut, whom we're talking about.
"I've been calling for more than an hour!"
Then turning about—he fell in a faint!
He'd forgotten to turn on the power.

—*W7FPP*

# Buyer's Guide

## Where to Buy It

### NORTON F.M. EQUIPMENT

F.M. Exciter

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$C_1$—Hammarlund MC-140-S
$C_2$—Hammarlund MC-50-S
$C_3$, $C_8$, $C_{17}$, $C_{18}$—Sprague 1FM-31
$C_4$, $C_{12}$, $C_{14}$—Sprague TC-11
$C_5$—Sprague TC-2
$C_6$, $C_7$, $C_9$, $C_{10}$, $C_{11}$—Sprague 1FM-25
$C_{13}$—Sprague UT-8
$C_{15}$—Sprague TA-25
$C_{16}$—Sprague TC-15
$C_{19}$—Sprague 1FM-35
$C_{20}$, $C_{21}$, $C_{22}$, $C_{23}$—Sprague TC-15
$R_1$, $R_2$, $R_3$, $R_4$, $R_6$, $R_7$, $R_8$, $R_9$, $R_{11}$ to $R_{18}$, inclusive—Centralab 710
$R_5$—Centralab 516
$R_{10}$—Centralab 72-105
RFC$_1$, RFC$_2$, RFC$_3$—National R-100
IFT—Meissner 16-6211

Phase-Modulated Exciter

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$C_1$, $C_2$—Johnson 75J12
$C_3$—Johnson 50J12
$C_4$—Hammarlund SM-100
$C_5$, $C_9$, $C_{29}$—Sprague TC-15
$C_6$, $C_7$, $C_{11}$, $C_{12}$, $C_{15}$, $C_{16}$, $C_{17}$, $C_{20}$, $C_{21}$, $C_{22}$, $C_{23}$, $C_{25}$, $C_{28}$—Sprague TC-11
$C_8$, $C_{18}$—Sprague 1FM-31
$C_{10}$—Hammarlund MEX
$C_{13}$, $C_{27}$—Sprague TC-1
$C_{14}$, $C_{24}$—Sprague 1FM-23
$C_{19}$—Sprague 1FM-35
$C_{26}$—Sprague TA-10
$R_1$ to $R_6$, inclusive, $R_8$ to $R_{21}$, inclusive, and $R_{23}$ to $R_{27}$, inclusive—Centralab 710
$R_7$—Sprague 5K "Koolohm"
$R_{22}$—Centralab 72-105
$X_1$, $X_2$—Bliley BC-3

### RYDER VACUUM-TUBE VOLTMETER

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$C_2$, $C_8$, $C_{10}$—Aerovox type PBS25
$C_3$, $C_5$, $C_6$, $C_{11}$—Mallory type CS-135
$C_4$, $C_{12}$—Solar type LG5-88
$C_{14}$, $C_{15}$, $C_{16}$—Solar type LG5-888A
R—See text
$R_1$, $R_2$, $R_3$, $R_4$, $R_5$—IRC type WW-5
$R_6$, $R_7$, $R_9$—IRC type BW-1
$R_8$, $R_{11}$, $R_{12}$, $R_{13}$, $R_{15}$, $R_{16}$, $R_{17}$, $R_{18}$, $R_{19}$, $R_{20}$—IRC type BT-½
$R_{10}$, $R_{14}$, $R_{21}$, $R_{23}$, $R_{26}$, $R_{27}$, $R_{28}$—IRC type BT-1
$R_{22}$—IRC type 11-120
$R_{24}$, $R_{25}$—IRC type BT-2
T—Thordarson type T-13R11
$S_1$—Centralab type 1401
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M—Simpson type 27
Case—Bud type 1096
Tubes—RCA Cunningham

### TAYLOR CONVERTER

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$C_4$, $C_5$, $C_6$—Micamold
$C_7$, $C_{11}$, $C_{12}$, $C_{16}$—Sprague type 2
$C_8$, $C_9$—Cornell-Dubilier type 1-W
$C_{10}$, $C_{13}$, $C_{14}$, $C_{17}$, $C_{18}$—Mallory type TP-415
$C_{19}$, $C_{20}$—Mallory type BB-61
$R_1$, $R_2$, $R_3$, $R_4$, $R_5$, $R_6$, $R_7$, $R_8$, $R_{10}$—Erie
$R_9$—Ohmite "Brown Devil"
T—Thordarson T-13R12
$S_1$, $S_2$—H & H
CH—Thordarson T-44C02
$L_3$—Meissner 16-8091 i.f. transformer
RFC—Wound on IRC type F-1
Coil bases—Millen 40105
Sockets—Amphenol
Dial—National type ACN
Terminal strip—National type FWG
Chassis—Bud 662
Tubes—RCA

## What's New

[*Continued from Page 76*]

ally in series when mounted on a threaded steel rod which is provided, and which can be cut to desired length. Mounting feet and ceramic end-spacers are also supplied. Several resistor sections can be connected in series and be mounted on the same tie rod and mounting feet, with a similar assembly insulated from it electrically by means of the ceramic spacers.

Overall length of the 10-watt Type VD Koolohm is 1⅛″ and diameter is ⅝″. The 15-watt sections are 1 9/16″ long and 11/16″ in diameter. The units are manufactured by The Sprague Specialties Co., Resistor Division, North Adams, Mass. Complete catalog will be sent upon request.



## *From the Mail Bag of the FCC*

The Commission recently issued a ham ticket to a 21-year-old Brooklyn youth. There was nothing remarkable about that, in itself. However, this particular applicant is deaf, dumb, and blind! He took the written examination at the Commission's nearest field office, submitting 30 pages of answers written by himself on a Braille typewriter. In the code reception test he demonstrated that he could "hear" by means of the vibrations produced by special devices.

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# NC-45

## THE NC-45

Series valve noise limiter with automatic threshold control.

Improved AVC Circuit.

Eight tube superheterodyne circuit.

Full vision dial with separate bandspread condenser.

Tone control.

CW Oscillator.

Four range coil switch, 550 KC to 30 MC.

Three models—for batteries, for AC-DC and for AC only.

**Amateur Net Price $57.50**
including speaker and tubes

## THE NC-200

Sensitivity better than one microvolt.

Series valve noise limiter.

Improved crystal filter with rejection ratios as high as 10,000 to 1.

Stability 3 parts in 100,000 for 20 volt line fluctuation.

AC line or portable operation.

Speaker in matching cabinet.

**Amateur Net Price $159.50**
without speaker

# NC-200

**Designed to Keep You Technically Up-to-the-Minute!**

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These RCA publications bring you the tube data and engineering help you need—when you need it—and in its most authentic and up-to-the-minute form. For years, RCA engineering has led the way, and these publications keep you fully abreast of modern tube design and application. They are available through RCA Tube and Equipment Distributors, or from RCA, Commercial Engineering Section, Harrison, N. J.

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Now available with a 38-page supplement covering 99 additional receiving tube types and making the book a virtual encyclopedia, with a total of 256 pages covering 333 different receiving tube types.

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**For Canadian prices write to RCA Victor Company Limited, Montreal**